TAMPEREEN TEKNILLINEN YLIOPISTO
TAMPERE UNIVERSITY OF TECHNOLOGY

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ENVIRONMENTAL MANAGEMENT AT A MACHINE MANUFACTURING FACTORY

Master of Science Thesis

Professor Jouni Kivistö-Rahnasto has been appointed as the examiner at the Council Meeting of the Faculty of Natural Sciences on March 1st, 2017

ABSTRACT

MATILDA KIRJAVAINEN: Environmental Management at a Machine Manufacturing Factory
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The purpose of this study is to analyze the current state of environmental management in a machine-manufacturing factory based on the requirements of ISO 14001:2015 and initiate the necessary development projects. The Metso Minerals Lokomo factory area is a traditional industrial area only 1,0–1,5 kilometers away from the Tampere city center. The local HSE organization has recently undergone changes, and the Metso Corporation has an ambitious energy efficiency program that currently emphasizes the role of maintenance in environmental management. The research seeks to find the best next steps.

The current state of environmental management is analyzed by a qualitative comparison between the current state and the requirements of SFS-EN ISO 14001:2015. Each subclause of ISO 14001:2015 is evaluated with 0–5 points based on the knowledge gathered in a document analysis and by interviewing the key employees. The recommendations are given based on the deficiencies found in the analysis. The necessary development projects are initiated within the resources available.

The current level of local environmental management, 74/110 points in the analysis, is characterized by an excellent understanding of the organization and its context, a high-level corporate environmental policy, excellent operational planning and control, and a high level of continual improvement in general. However, there are still major deficiencies, such as documenting the environmental risk analyses and HSE legislation follow-up, that need immediate development actions. The minor deficiencies are related to the documented identification of environmental aspects and impacts, managing the amount of stored chemicals, environmental awareness, and formal environmental competence.

The local emergency and rescue plan is updated to offer a good basis for the environmental risk analysis and for the upcoming environmental trainings. Recycling and energy savings related projects are initiated to support reaching the energy efficiency targets each year by 2020 as successfully as before 2017. The attitude of the managers and specialists turns out to be a crucial factor in keeping the employees motivated and active. When addressed with an issue, the managers and specialists should be able to offer practical support.

TIIVISTELMÄ

MATILDA KIRJAVAINEN: Ympäristöjohtaminen koneita valmistavalla tehtaalla
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Tämän tutkimuksen tarkoituksena on analysoida koneita valmistavan tehtaan ympäristöjohtamisen nykytila standardin ISO 14001:2015 vaatimuksiin perustuen ja käynnistää tarvittavat kehitysprojektit. Metso Mineralsin Lokomon tehdasalue on perinteinen teollisuusalue, joka sijaitsee vain noin 1,0–1,5 kilometrin päässä Tampereen keskustasta. Paikallisessa HSE-organisaatiossa on hiljattain tapahtunut muutoksia, ja Metso-konsernilla on kunnianhimoinen energiansäästöohjelma, joka tällä hetkellä korostaa kunnossapidon roolia ympäristöjohtamisessa. Tutkimus pyrkii kartoittamaan parhaat tulevat kehitysaskeleet.

Ympäristöjohtamisen nykytila analysoidaan laadullisella vertailulla vertaamalla nykytilaa SFS-EN ISO 14001:2015:n vaatimuksiin. Jokainen ISO 14001:2015:n alakohta arvioidaan 0–5 pisteellä perustuen dokumenttianalyysissä ja avainhenkilöiden haastatteluissa kerättyihin tietoihin. Suositukset annetaan analyysissä havaittujen puutteiden pohjalta. Tarvittavia kehitysprojekteja käynnistetään käytettävissä olevien resurssien mukaisesti.

Paikallisen ympäristöjohtamisen nykytilaa, analyysissä 74/110 pistettä, kuvaavat erinomainen organisaation ja sen toimintaympäristön ymmärtäminen, korkeatasoinen ympäristöpolitiikka, erinomainen toiminnan suunnittelu ja ohjaus sekä yleisesti ottaen korkeatasoinen jatkuva parantaminen.

Myös oleellisia puutteita on yhä: ympäristöriskien arvioinnin dokumentointi ja HSE-lainsäädännön seuranta tarvitsevat välittömiä kehitystoimenpiteitä. Vähäiset puutteet liittyvät ympäristönäkökohtien ja -vaikutusten dokumentoituun tunnistamiseen, varastoitujen kemikaalien määrän hallintaan, tietoisuuteen ympäristöasioista sekä muodolliseen pätevyyteen ympäristöasioissa.

Paikallinen pelastussuunnitelma päivitetään, jotta se tarjoaa hyvän pohjan ympäristöriskien arvioinnille ja tuleville ympäristökoulutuksille. Kierrätykseen ja energiansäästöön liittyviä projekteja käynnistetään tukemaan vuosittaisten energiansäästötavoitteiden toteutumista vuoteen 2020 mennessä yhtä tehokkaasti kuin ennen vuotta 2017. Johtajien ja asiantuntijoiden asenne osoittautuu ratkaisevaksi tekijäksi työntekijöiden motivaation ja aktiivisuuden ylläpitämisessä. Kun jokin ongelma otetaan esiin, johtajien ja asiantuntijoiden tulisi pystyä tarjoamaan käytännönläheistä apua.

PREFACE

This master's thesis project was an interesting journey of work that started in the underground canals under the factory and ended on the highest roof. I worked for Metso Minerals as a member of the Operations Development team of Tampere. The team belongs to the manufacturing organization of the factory in Tampere and works closely with all production operations.

I want to warmly thank everyone who shared their valuable working hours with me. Kimmo Leikko, Mikko Irri, Vesa Nevalainen, Petri Kiiskilä, Tuomas Virtanen, Pirjo Virtanen, Risto Lukkari (Lassila & Tikanoja), Mauno Annala, Jorma Aronen (Tevo Lokomo), the global Metso HSE professionals, and of course every other person who provided me with valuable information and possibly got some new ideas in exchange. I also want to thank the factory steering committee led by Ville Seppälä for giving me this opportunity and expressing genuine interest towards continuous improvement. From Tampere University of Technology, I want to thank professor Jouni Kivistö-Rahnasto for valuable comments and patience with students who tend to get lost in the jungle of exciting new ideas and projects.

My family, relatives, good old friends. The amount of support I got from you all during my studies was incredible. When being passionate was not enough, you were there to show what truly is important in life.

I have now continued my journey with energy and environmental engineering, taking a different path but aiming for the same goals. One day, I want to look back and see that we made a difference. I humbly and happily admit that this was only the beginning, not the ending. The environment needs us all.

In Tampere, Finland, 21.9.2017

Matilda Kirjavainen

SISÄLLYSLUETTELO

TERMS AND ABBREVIATIONS

ALARA	as low as reasonably achievable, a risk reduction principle (see also ALARP)
ALARP	as low as reasonably practicable, a risk reduction principle (see also ALARA)
BAT	best available technology; best available technique
CO_2	carbon dioxide
DDT	dichlorodiphenyltrichloroethane, a pesticide
EED	Energy Efficiency Directive, a legal act of the European Union, establishes a set of binding measures to help the EU reach its energy efficiency targets
EMAS	Eco-Management and Audit Scheme, a management instrument developed by the European Commission
EMS	environmental management system
eco-efficiency	a controversial term that refers to using natural resources as little as possible with as little waste as possible, getting as much benefit as possible
end-of-pipe technology	an approach to control industrial pollution by using different methods with technological equipment before releasing the harmful discharge into the environment, as opposed to making beneficial changes in the production process itself
environmental program	a limited-time or a cyclic project with certain environmental goals, carried out in order to save natural resources and often also money
GRI	Global Reporting Initiative
HR	human resources; the human resources department
HSE	health, safety, and the environment
HSEQ	health, safety, the environment, and quality
in addition to other duties	a set phrase, sometimes referred to as IATOD, refers to a responsibility situation where the employee in question takes care of tasks not included in the main role and has a second role that is not automatically included in the main job description
L&T	Lassila & Tikanoja Public Limited Company, a Finnish service company
LCA	life cycle assessment
lean	*lean management* and *lean production* refer to the management philosophy that aims at eliminating different types of waste and making all operations happen *just in time*
limits to growth	calculated maximum levels for constantly growing human consumption of different natural resources, these are limits that cannot be exceeded without a collapse of the whole system; *The Limits to Growth* is a pioneering environmental report published in 1972
MEEP	Metso Energy Efficiency Program, Metso's leading environmental program
MDGs	The United Nations Millennium Development Goals

Mtoe	megatoe, one million toe, a normalized unit of energy defined as the amount of energy released by burning one million metric tons of crude oil
NRBV	a management theory of competitive advantage based upon the firm's relationship to the natural environment, emphasizes that a successful company cannot ignore the constraints imposed by the biophysical (natural) environment when gaining competitive advantage
PDCA	plan, do, check, act – the cyclic development process on which most management standards are based
policy	a statement that sets the guiding principles and rules of action which have to obeyed in decision-making and everyday actions regarding some area of the company's business activity
SDGs	The United Nations Sustainable Development Goals
strategy	a unique set of decisions that explains how the company will achieve certain targets and a certain market position with the limited resources available
sustainability	the ability to sustain: the ability to remain diverse and productive indefinitely; a wide ethical concept that consists of several parts, such as environmental, social and economic sustainability
Tukes	The Finnish Safety and Chemicals Agency
VOC	volatile organic compound

1. INTRODUCTION

Proper environmental planning and managerial control ensure the best possible market opportunities and trading partners for a company (Edwards 2001, pp. 1–2). That is because environmentally responsible companies can be expected to be trustworthy partners with well-developed risk management procedures in environmental management as well as in financial risk management. As environmental legislation continuously grows in complexity, especially manufacturing companies need to acquire new kinds of knowledge, skills, and managerial practices (see for example Ervin et al. 2013, pp. 390–392, 404–406). It is also crucial to pay attention to change management. The amount of change management activity has been found out to positively correlate with the future environmental performance of the firm that implemented an environmental management system (EMS). (Ronnenberg et al. 2011, p. 641.)

Especially in old manufacturing companies, there are always existing buildings and processes from the era when environmental management was not integrated in management and planning. Integrating this important new viewpoint into an existing system can best be done by creating and implementing a formal environmental management system (Maier & Vanstone 2005, p. 1–12). A new environmental system can be created by creating a set of documents and procedures. However, implementing the EMS is not straightforward work that could be conducted by one person only. It can only be implemented with strong managerial support for behavioral change at all management levels and adequate resources for environmental investments and reporting. (See for example Pochyluk 1998, Ronnenberg et al. 2011, and Famiyeh et al. 2014.)

The Lokomo factories of Metso Minerals in Tampere have been operational since 1915 (Törmä 2015). The recent changes in roles and responsibilities regarding both occupational health, safety, and environmental (HSE) work and factory maintenance have caused vagueness in environmental responsibilities. The factory steering committee wants to know the current state of local environmental management to be able to manage the environmental issues properly in the future. Local environmental data has been separately reported for Metso HSE, Metso Energy Efficiency Program (MEEP), The Federation of Finnish Technology Industries, and WWF Green Office. Still, the connection between reporting and systematically planning local development steps has been vague. The environmental savings targets within the MEEP program (2009–2020) have also emphasized the importance of proper planning in reaching targets.

The target of this Master's Thesis project is to define the current state and initiate the next steps of local environmental management at the Tampere factory of Metso Miner-

als. ISO 14001 is currently the most well-known environmental management system standard in the world. The current state of environmental management in the case company will be evaluated based on the requirements of ISO 14001:2015. The research methods will be unstructured, informal interviews and a qualitative document analysis. As a result, this thesis project will produce draft versions of the documents needed for a local environmental management system and initiate development projects that are needed based on the analysis findings. Recommendations regarding the next steps will be given based on the deficiencies. When reading the recommendations, it is necessary to keep in mind that the site is not aiming for an official ISO 14001 certificate, but at better environmental performance and full legal compliance.

Environmental aspects in product design, product life cycle, sustainable supplier chain management, and Metso life cycle and maintenance services offered for customers will be excluded from the scope of this thesis project. Investigating the environmental benefits of different factory layouts and factory automation will also be excluded. These delimitations are based on the structure of the organization of Metso Minerals and the short time period available.

After this project, the local Operations Development Team and the local factory steering committee will continue implementing these environmental management procedures together with the appropriate managers from the production organization. The team will also take the responsibility of updating the instructions created in this project.

2. THEORETICAL BACKGROUND

The Environmental Protection Act (527/2014) forms the basis for the environmental responsibility of industrial companies in Finland. It implements the European Union directive on industrial emissions. Every operator has the obligation to be aware of the environmental impacts, environmental risks, the control of the risks identified, and the possibilities to reduce the harmful impacts. The operator has to prevent all environmental pollution, and where not entirely possible, restrict it as much as possible. (Ministry of the Environment of Finland 2016a.)

Environmental management is an interdisciplinary approach to resource conservation and recycling (Agarwal 2005). The field interacts with business, law, and science. It aims at defining how business strategies and production methods must change in the face of environmental constraints and the demand for sustainable production. (See for example Learn.org 2016.)

Environmental management is an important part of HSE (health, safety, and environmental) work in industrial companies. It has been shown that occupational accidents have a relatively small impact on human health. The majority of human health impacts are caused by the release of emissions into air. Focusing on emissions does not only benefit the environment, but also the people. However, only striving exclusively towards better environmental performance in manufacturing processes and product design can increase negative occupational health impacts. (See for example Huuskonen 2012.) That is why it is also important to understand occupational health and safety when managing environmental aspects. Managing occupational health, safety and the environment as one entity, HSE, is the best way to ensure the optimal HSE performance.

2.1 Environmental sustainability

Sustainability is an ethical concept that describes continuity in the relationships of the humankind. These relationships are (1) the relationship between humans and their contemporaries, (2) the relationship between currently living humans and future generations, and (3) the relationship between human and nature. (Becker 2012, pp. 9–15.)

The concept of sustainability consists of three parts: environmental, social and economic sustainability. Environmental sustainability is concerned with pollution prevention and efficient use of resources at a rate at which the usage could theoretically be continued indefinitely. Often also ethical points of view, such as the immeasurable value of

untouched nature and the responsibilities societies have or should have towards nature, are also included in the concept. (See for example Becker 2012 or Heiskanen 2004.)

Corporate environmentalism is one term that is used to describe the work companies do for environmental sustainability. It has been defined as "the recognition and integration of environmental concerns into a firm's decision-making process" (Banerjee 2002, p. 177). Similarly, environmental management can be described as a systematic way of managing and controlling corporate environmental sustainability.

2.1.1 The historical background and development of environmental management

Rachel Carson's 1962 book *Silent Spring* has been seen as the first milestone of the environmental movement (Paull 2013, p. 1). The economic boost of the 1940s and the 1950s made the effects of the new synthetic chemicals visible (Heiskanen 2004, p. 22). Silent Spring documented the detrimental effects of pesticides, especially DDT (dichlorodiphenyltrichloroethane), on the environment. The book ignited an international debate. It was not the first book about an environmental issue, but it succeeded at becoming a driver of major awareness and change. (Paull 2013, pp. 1–10.) The U.S. Environmental Protection Agency (EPA) was founded in 1970 largely in response to Silent Spring. In 1972, the EPA first cancelled all Federal registrations of DDT products, and by the end of the year, the usage of DDT was banned in the United States. (Paull 2013, p. 2.)

The Silent Spring case showed to both the public and industrial corporations that the environmental impacts of human activities must be taken seriously. The Great Smog of London in 1952 had already shown that pollution in the environment could be lethal (Ito & Thurston 1989). Environmental accidents, such as the Seveso accident in 1976 and the Exxon Valdez oil spill in 1989, were the other driver for environmental regulations. They aroused public anger, which created pressure for new regulations. New environmental legislation created the need for new skills and knowledge on how to manage environmental impacts and risks. (For Finnish examples, see for example Heiskanen 2004.)

The oil and energy crises in the 1970s created a temporary urge to develop new ways to use materials and energy more efficiently. However, by the 1980s, new technologies seemed to provide solutions for the depletion of materials and resources. Energy efficiency became less important for some time, as fast-developing end-of-pipe technology seemed to make it possible to exceed the limits to growth. (Heiskanen 2004, p. 22–26.)

Environmental problems caused by industrial companies can be seen as examples of unregulated externalities. Externalities are externally occurring "side effects" that affect a party that did not choose the process, nor its costs or benefits. Environmental re-

sources, like clean air and soil, don't automatically have a trade representative. They are often left unpriced, or at least underpriced, by the society. This kind of resource valuing creates incentives for economic agents to use more of those resources than is socially efficient. Environmental goods are often thought of as public goods, which too often makes them an uninteresting target for improvement, that is, for investing and high-quality maintenance. This is especially the case in private manufacturing companies because they can't necessarily clearly benefit from improving the state of the natural environment around them. (Reinhardt 1998, p. 3.)

In the past, it was first argued that internalizing costs coming from maintaining natural resources would simply lead to the company not surviving. However, as environmental problems became more and more evident globally, more and more companies chose even a beyond-compliance environmental strategy. (Reinhardt 1998, p. 3.) Simply following legislation changes and reacting to them was not enough anymore. Four different explanations have been offered to explain the emergence and benefits of beyond-compliance environmental strategies (Reinhardt 1998, pp. 3–15):

1) An appropriate environmental strategy could increase the expected revenues and lower the expected costs. Thus, it could increase the expected shareholder value of the company.
2) A comprehensive policy for the management of business risks is always needed, and environmental issues are extremely topical.
3) It is always beneficial to work on reductions of environmental impacts because using less virgin materials and causing fewer emissions saves money.
4) Eco-design is a means of product differentiation, and product differentiation is needed so stay competitive in the modern market environment.

It can be stated that the need to better control environmental risks was the initial driver for highly ambitious environmental strategies. Companies needed to find a systematic way to manage environmental risks in such a manner that would bring them economic benefits as well, not just protection against crises and losing reputation. When a company then could present a proper environmental strategy, the strategy increased the expected shareholder value of the firm. The increase was due to a better reputation and brand name, lowered expected costs, and thus also increased expected revenues. (See Reinhardt 1998, pp. 3–15.) When a reasonable number of companies in a certain business area had invested in taking care of the environment, a new economic equilibrium was established.

Environmental management means keeping control of the company's activities so that 1) polluting physical resources is being avoided and 2) physical resources are being conserved. Every company should take environmental factors into account for ethical, economic, legal (reputation), and commercial reasons (brand value). (Edwards 2001, pp. 1–2.) Environmental management should not be a separated field of management inside

a company, but instead, an inseparable part of all management activities. In practice, the environmental managers and other environmental employees should not be placed outside the decision-making forums as lobbyers. They must be invited to join the groups that make the decisions.

The first formal environmental management standard, BS 7750, was published in 1992. The success of the former quality management standard BS 5750 (as ISO 9001 was then known in the UK) had given a model for what a good management system standard should cover. BS 7750:1992 *Specification for environmental management systems* was tested with 40 sectoral groups of companies to ensure that it was a workable and an effective standard. Experiences from the pilot schemes led to revisions. The first general version of the standard was published in 1994. By 1995, official certification bodies had been accredited and the first environmental management system certificates could be awarded. (Edwards 2001, p. 8.)

Already in 1996, researchers were able to propose a model linking strong environmental management to improved financial performance, measured by stock market performance right after positive environmental events. In a pioneering study conducted by Klassen and McLaughlin (1996), the marketplace clearly rewarded firms that invested in such areas as new or redesigned products and processes that minimized negative environmental impacts, improved environmental safety systems, and developed strong management programs to support environmental development.

Maier & Vanstone (2005) studied the correlation between environmental management systems and environmental performance improvement. The three-year study concluded that there is indeed a broad correlation between well-developed environmental management systems and improved environmental performance. Adopting an environmental management system reduced the overall environmental impact of the company especially when the company had no EMS yet in place. In general, the more advanced the EMS, the higher the level of performance achieved was. However, the evidence that an EMS would always or automatically lead to improved process efficiency was not very strong. A documented environmental management system did not automatically improve process efficiency or environmental performance, as measured by environmental impact indicators such as compliance, process efficiency, and releases. Still, none of the companies that had not implemented an EMS achieved major improvement during the time span of three years.

As more and more big corporations adopted *lean* philosophy in their production in the early 2000s, waste elimination became an important topic. Lean management made waste management an important topic. It gave a reason to rethink production processes and why they produce waste. Even though lean production is primarily a method to produce better quality at lower costs, it has often been stated that is also benefits the environment. (See Hajmohammad et al. 2013, pp. 313–314.)

Hajmohammad et al. (2013) studied the role of lean management in green practices and environmental performance. The results indicated a significant positive path between environmental practices and environmental success. Lean management philosophy itself did not seem to lead companies towards environmental success. However, integrating environmental practices into lean management seemed to mediate success. Lean management did have a positive impact on environmental performance, but successful development still required separate environmental management as well. Any investment in environmental practices, including management systems (software or infrastructural elements) or pollution prevention (hardware or structural elements), was linked with reduction in the amount of pollutants and energy consumption. (Hajmohammad et al. 2013, pp. 316–317.)

Since the 1990s, environmental practices and organizational performance, including environmental performance, have been linked through the natural resource-based view (NRBV). The NRBV proposes that proper environmental management can help companies develop capabilities that are valuable, rare, and difficult to replicate by competitors. These kinds of capabilities can help any company gain competitive advantage. (See Hajmohammad et al. 2013, p. 313.) Pursuing environmental strategies can also be an economic choice, not just an ethical choice.

Finnish literature from the early 2000s emphasizes the importance of change in managers' and also employees' attitude when aiming at success. Improvement in environmental performance requires a change in thinking. It is also important to understand that a forced one-time development project does not form a sustainable basis for systematically decreasing environmental impacts. Environmental management has to be a part of the organization and its processes, not just a single project. (See for example Heiskanen 2004.)

However, as Halme (2004) explains (see Heiskanen 2004, p. 161), literature from the 1980s and the 1990s claims, with good reason, that changes in daily routines and operations *are* possible even before the organizational culture and attitudes have changed. Making the actions themselves valuable and important to people can also create positive change. It is a good idea to aim at systematically rewarding daily actions that are strategically useful to the company, even if rewarding does not change people's attitudes. Little by little, repetition will make these actions – such as recycling, replacing harmful chemicals, and reporting every environmental incident and risk – a part of the company culture. Their importance will be learned as a belief. Acting in any different way will start to feel uncomfortable. Rewarding different kinds of environmentally valuable actions can be useful for the company's culture, even when the employees are not openly willing to change their attitudes and values.

2.1.2 The Sustainable Development Goals (SDG) index for Finland

The *High-level Political Forum on Sustainable Development* is United Nations' central platform for the follow-up and review of the *2030 Agenda for Sustainable Development and the Sustainable Development Goals*. It was adopted at the United Nations Sustainable Development Summit in 2015. 22 countries volunteered to conduct national reviews of their way of implementing the 2030 agenda. Finland was one these countries. (United Nations Department of Economic and Social Affairs 2016a.)

Finland was among the first countries to establish a National Commission on Sustainable Development, only one year after the 1992 United Nations Conference on Environment and Development (UNCED). Finland has implemented various programs on sustainable development since the 1990s. These programs led to the adoption of a comprehensive National Strategy for Sustainable Development in 2006. The latest strategy for sustainable development was adopted in 2013 and updated in 2016 to be in line with the 2030 Agenda for Sustainable Development. The strategy is called "The Finland we want by 2050 – Society's Commitment to Sustainable Development." (United Nations Department of Economic and Social Affairs 2016b.)

The United Nations Millennium Development Goals (MDGs) produced impressive results. However, the MDGs did not include the full spectrum of global issues regarding inequality and environmental issues. The new Sustainable Development Goals (SDGs) were established in 2015 to fill the gaps. Environmental sustainability, green energy, sustainable consumption, sustainable production patterns, and tackling climate change were added on the demand list. The SDGs are not legally binding goals, however, but merely political goals. (Kroll 2015, p. 4–5, 10–11.)

The Sustainable Development Goals Index illustrates the overall performance of each OECD country based on the 17 sustainability goals and 34 indicators examined in the study by Kroll (2015) for the historic United Nations Summit in New York in 2015.

The SDG index of Finland (figure 1) shows that Finland is developing well. However, it still needs to focus more on its high energy intensity and domestic material consumption in its sustainability work (see Kroll 2015, p. 26).

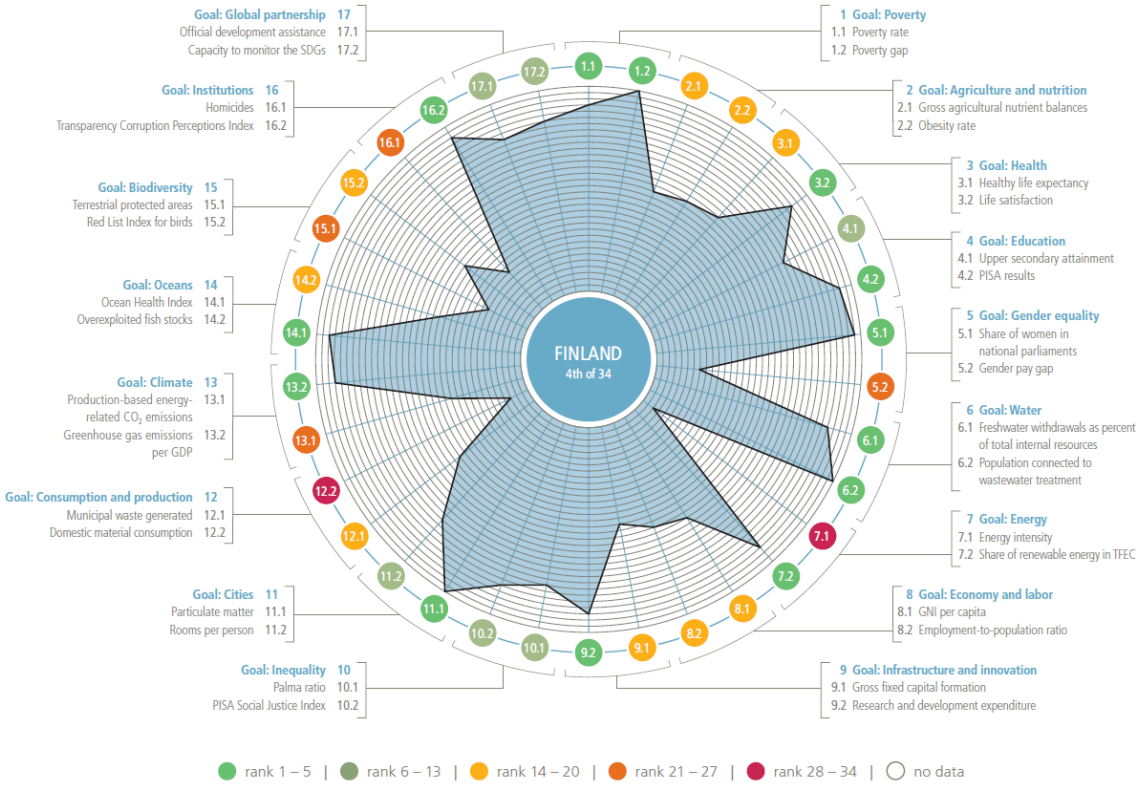

Figure 1. *In general, Finland is doing well in sustainable development. It was rated as the 4th best country in sustainable development in a comparison of 34 OECD countries carried out for the United Nations in 2015. (See Kroll 2015, p. 26.)*

The "sustainability stress test" of OECD countries in 2015 showed that especially Sweden, Norway, Denmark, Finland, and Switzerland could be considered ready for the SDGs. These countries, the "fit five", are therefore now in a good position to foster further improvements in terms of sustainable development going forward. (Kroll 2015, p. 5.)

In spite of the good development, even the "fit five" nations still have significant deficiencies with regard to certain goals, as the country profiles illustrate. Strong policy efforts are needed in most countries to reach the ambitious set of sustainability goals by 2030. (Kroll 2015, p. 5.)

2.2 Environmental legislation and authorities in Finland

Environmental legislation in Finland is nowadays based on that of the European Union (EU). Finland joined the European Union in 1995. The most important environmental authorities in Finland are Ministry of the Environment, Regional State Administrative Agencies (AVI), The Centres for Economic Development, Transport and the Environment (ELY Centres), and The Finnish Safety and Chemicals Agency (Tukes).

Environmental legislation in Finland and in the EU is based on the following principles and general duties (see Ministry of the Environment of Finland 2016a):

- the prevention or reduction of harmful impacts (principle of preventing and minimizing harmful impact),
- the use of the best available technique (BAT principle), and
- the use of best practices to prevent pollution (principle of environmentally best use).

All parties engaged in any activities that can pose a risk of pollution have a duty to prevent or at least minimize harmful impacts. Every party has a responsibility to know the potential environmental effects and according to the risks that the activity may pose. (Ministry of the Environment of Finland 2016a.) With the use of best available technique or technology, or sometimes best practicable means or best practicable environmental option, it has to be taken into account that any kind of BAT is always a moving target. Companies have to follow the development of environmental technologies to be able to choose the kind of BAT that is currently reasonably achievable.

EU environment policy rests on the principles of precaution, prevention and rectifying pollution at source, and on the polluter pays principle. The precautionary principle means that a chemical or other product can be removed from the market if it is potentially harmful to human health or the environment and uncertainty persists even after an objective scientific evaluation. Such measures are reviewed once more scientific information is available. (European Parliament 2016.)

The Environmental Protection Act (527/2014) implements the European Union directive on industrial emissions (integrated pollution prevention and control, IED), which obliges EU member states to integrate the control of emissions caused by industry. The following legislation forms the basis for environmental work at machine manufacturing plants in Finland. (Ministry of the Environment of Finland 2016a, Ministry of the Environment of Finland 2016b, Ministry of the Environment of Finland 2017.)

Environmental legislation (general):

- Environmental Protection Act (527/2014)
- Environmental Protection Decree (713/2014)
- The Water Act (587/2011)

Waste legislation (general):

- Waste Act (646/2011)
- Waste Decree (179/2012)

- Council Regulation establishing criteria determining when certain types of scrap metal cease to be waste under Directive 2008/98/EC of the European Parliament and of the Council (NO 333/2011)
- Government Decree on Batteries and Accumulators 520/2014
- Government Decree on waste incineration (151/2013)
- Government Decree concerning the recovery of certain wastes in earth construction (591/2006)

Chemical legislation (general; Finland):

- Chemicals Act 599/2013
- Act on the Safe Handling and Storage of Dangerous Chemicals and Explosives, Chemicals Safety Act 390/2005
- Health Protection Act 763/1994
- Act on Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment 387/2013
- Government Decree on Substances Dangerous and Harmful to the Aquatic Environment 1022/2006
- Government Decree on Urban Waste Water Treatment 888/2006
- Government Decree on the Monitoring of the Handling and Storage of Dangerous Chemicals 685/2015
- Government Decree on Air Quality 79/2017

Chemical legislation (general; the EU):

- REACH and GHS
- RoHS

In addition, knowledge of legislation on specific products, manufacturing processes, occupational safety, waste types, and waste shipments can be needed in environmental management (see for example Ministry of the Environment of Finland 2016a). Knowledge of chemical legislation is always needed in the environmental management of manufacturing companies. One of the primary goals of chemicals legislation is to prevent the environmental impacts of chemicals before they cause any negative impacts. The chemicals legislation of the European Community has been significantly updated in recent years. In addition to the REACH Regulation, there are several other community-level regulations that concern chemicals and can be directly applied in the member countries. (Ministry of the Environment of Finland 2017.)

Due to the environmental impacts of energy production, also energy-related regulations are often considered a part of environmental regulation. Finland's national climate change legislation reflects the obligations imposed by international conventions and the EU. The Climate Change Act (609/2015) defines the long-term guidelines for Finland's climate change policy. The key element of the Climate Change Act is the greenhouse

gas emissions reduction target: Finland is committed to an 80 % reduction in greenhouse gas emissions by 2050, compared to the emission level of 1990. The Act also introduces a planning system for administrative actions for reducing emissions in sectors outside the Emissions Trading System and the ways of monitoring the implementation. (Ministry of the Environment of Finland 2016c.)

2.3 The EED energy efficiency agreement in Finland

The 2012 Energy Efficiency Directive (EED) establishes a set of binding measures to ensure that the European Union can reach its energy efficiency targets. By 2020, the EU has promised to cut off 20 % of its primary energy consumption. Each EU country has set its own target. In Finland, the primary energy consumption level was 35,9 Mtoe per year. The final energy consumption target was set at 26,7 Mtoe. Under the EED, all EU countries are required to use energy more efficiently at all stages of the energy chain from its production to its final consumption. In November 2016, the European Commission proposed an update to the EED. The update includes a new 30 % energy efficiency target for 2030. (European Commission 2016.)

In Finland, voluntary Energy Efficiency Agreements are an important part of the country's energy and climate strategy. Together with tightening environmental legislation, they are the primary tools for improving the efficient use of energy. As long as the agreement scheme is comprehensive and successful, Finland can continue to meet the obligations without separate new legislation. (Motiva Oy 2016.)

The first agreement period was 2008–2016. The current agreement period is 2017–2025. The four Energy Efficiency Agreements signed for the period 2017–2025 include Industries (Industry, Energy Sector and Private Service Sector), Property Sector, Municipal Sector, and Oil Sector (distribution of liquid heating fuels). The Federation of Finnish Technology Industries is one of the industrial associations participating in the agreement coordination. (Motiva Oy 2016.) Metso has long participated in energy efficiency programs coordinated by The Federation of Finnish Technology Industries. Metso is also committed to the 2017–2025 Energy Efficiency Agreement within the program.

Attending the program voluntarily offers some unique benefits to the companies. Most importantly, these companies are entitled to energy subsidies granted by the Government. Subsidies are granted to energy efficiency investments based on detailed applications. These subsidies are partial, which means that the companies applying still have to make their own investments. Compulsory energy audits of large companies are not subsidized. (See for example Motiva Oy 2016.)

Within voluntary Energy Efficiency Agreements, annual reporting of measures and savings is crucial. The agreement participants have to carefully report on their energy effi-

ciency improvement measures and other actions aiming at improving energy efficiency. Based on the participant reporting, Finland provides annual reports to the EU on the realized energy savings. Every implemented and reported measure of energy efficiency improvement helps Finland reach its target. (See Motiva Oy 2016.)

2.4 Environmental management system (EMS)

An environmental management system (EMS) is a documented set of policies and processes for managing the organization's environmental impacts, risks, and legal obligations in a systematic way. An EMS typically includes at least the following elements (Edwards 2001, p. 226):

- Environmental policy
- Environmental manual
- Registers of environmental aspects
- Registers of environmental legislation follow-up
- Operating procedures
- Work instructions

An environmental management system should be viewed as an organizing framework. It should be continually monitored and periodically reviewed to provide effective direction for the organization's response to changing external and internal issues. (SFS-EN ISO 14004:2016.)

An environmental management system standard can be used either as a general development guideline or a binding guideline leading to official certification. Because environmental management is a rather young field, referring to an official standard brings clarity to every decision made for organizational development. Officially committing to a standard gives a proper reason to add an additional viewpoint to all decision-making. An official certification granted by a third party shows to current and potential customers and commercial partners that the organization takes environmental issues seriously and is prepared to prevent environmental accidents. (See for example Edwards 2001.) Even if there is no customer pressure for a certification, the organization can still announce that it follows a certain standard as a guideline.

It has been noted in research literature that the existence of an EMS does not automatically improve the environmental performance of a company, not even with well-chosen targets. Despite this finding, the research data strongly supports the intuitive hypothesis that the companies which have performed well in reaching their environmental targets have also had a proper EMS as a basis for the development work. (See for example Maier & Vanstone 2005.) The research findings of Moutchnik (2015) also emphasize that environmental management has to be integrated into all other management activi-

ties in order to get favorable results on the environment. Environmental management is not supposed to be a separate process, but a part of all other management processes.

The environmental policy of the company forms the basis for the EMS. The policy is always public and has to be made available to all employees. It has a standard format. The exact content depends on the type of business environment in question and the environmental management standard followed. For example, ISO 14001 is very specific about what the environmental policy must include. Adding appropriate key points is allowed, but all the key points and goals mentioned in the management standard have to be presented from the company's own point of view. (Edwards 2001, p. 24.)

The elements that support the implementation and maintenance of an environmental management system are (SFS-EN ISO 14004:2016, p. 130):

- Leadership
- Resources
- Competence
- Awareness
- Communication
- Documented information

The extent to which the supporting elements are needed grows as the environmental management system is implemented (SFS-EN ISO 14004:2016, p. 129–130). Two different kinds of employee responsibilities have to be taken into account when evaluating the competence of the personnel and the need for support. In the organization, there are employees whose work has the potential to cause environmental impacts, and on the other hand, there are employees who have been assigned responsibilities regarding environmental management. These responsibilities can include determining and evaluating environmental impacts or compliance obligations, contributing to achieving environmental objectives, responding to emergency situations, performing internal audits, and performing evaluations of compliance. Both types of employees have to be aware of the organization's environmental policy and their own role in achieving the commitments. (See SFS-EN ISO 14001:2015.)

One of the many challenges within the field of environmental management is how to measure and assess environmental performance. Theoretically, a well-developed EMS also provides quantitative data on environmental performance to be included in environmental reports. However, environmental management standards only present this need on a very theoretical level. The environmental manager who builds the EMS has to know both the business environment and the company's strategy extremely well to be able to choose the best indicators. Also, basic mathematical knowledge is needed. In general, indicators of environmental performance can be absolute indicators (basic raw data), relative indicators (amount of resource consumption per unit of output), or indi-

ces. Indices are comparative indicators. They are constructed mathematically to produce a number by using a certain baseline year as a starting point. If the level of 2016 is chosen as the baseline, then “100” represents the performance of 2016. Increasing efficiency will produce a larger number through the use of appropriate factors and weighting. (See Maier & Vanstone 2005.)

The establishment of an environmental system may aim at an official EMS certificate. An official management system certificate granted by a third party can prove useful in terms of brand building, new customer relationship opportunities, and new opportunities regarding environmental permits and cooperation with local authorities. There are several accredited third parties that audit environmental management systems and grant certificates. The up-to-date list of these third parties is published on the website of Finnish Accreditation Service FINAS that is a part of Tukes. After a certificate has possibly been issued, the development work continues normally. The certificate is valid for several years. Before the end of that time, a new audit is required. All management system audits and certificates are subject to a fee.

2.4.1 ISO 14001:2015

ISO 14001 is a widely known international standard that is intended for use by an organization seeking to manage its environmental responsibilities in a systematic manner that contributes to the environmental pillar of sustainability. It specifies the requirements for an environmental management system. (SFS-EN ISO 14001:2015.) It does not state specific environmental performance criteria, which can be considered its greatest weakness in practice (see Marsh and Perera 2012).

ISO 14001 belongs to the family of ISO 14000 standards that serve as guidelines for all kinds of organizations that aim at systematically improving their environmental performance. The intended outcomes of an environmental management system created according to ISO 14001 include (SFS-EN ISO 14001:2015):

- Enhancement of environmental performance
- Fulfillment of compliance obligations
- Achievement of environmental objectives

ISO 14001:2015 is the newest version of the standard. It replaces ISO 14001:2004. Using an old standard is not advisable. All organizations following the 14000 standards are advised to carry out the necessary changes as new versions are published.

Choosing ISO 14001 over EMAS and other environmental management standards is justifiable in organizations operating globally. If customers and other cooperation partners require a confirmed level of environmental actions, it is often an ISO 14001 certificate that is used as validation.

The ISO 14000 family of standards consists of several environment-related standards that can be used as a guideline by several kinds of private and public organizations. In Finland, these standards can be purchased online on the website of the Finnish Standards Association SFS. SFS is a member of the International Organization for Standardization (ISO) and the European Committee for Standardization (CEN).

The ISO 14000 standards can be divided into two main groups: process-oriented standards and product-oriented standards. Process-oriented standards are related to the process of environmental management, environmental performance evaluation, and environmental auditing. Product-oriented standards are related more to wise product design decisions than environmental management, even though they do belong to the environmental standards family. They present the guidelines for environmentally friendly product design and product lifecycle planning. These business functions deal with environmental topics, such as product life-cycle assessment, environmental labeling, and environmental aspects in product standards.

Several well-known management system standards present the PDCA cycle: plan – do – check – act. The PDCA cycle is a basic guideline for any type of development work. In ISO 14001:2015, the PDCA is presented as an iterative management process used to achieve continual improvement. The process is as follows (SFS-EN ISO 14001:2015, p. 48):

- **Plan:** establish environmental objectives and processes necessary to deliver results in accordance with the organization's environmental policy.
- **Do:** implement the processes as planned.
- **Check:** monitor and measure processes against the environmental policy, including its commitments, environmental objectives and operating criteria, and report the results.
- **Act:** take actions to continually improve.

ISO 14001:2015 does not state specific environmental performance criteria. Any target and any PDCA-based development plan based on the target form a sufficient combination from the standard's point of view.

2.4.2 ISO 14004:2016

ISO 14004:2016 is an international standard that belongs to the ISO 14000 family. It provides guidance for the establishment, implementation, maintenance, and improvement of an environmental management system according to the requirements of ISO 14001. It covers understanding the organization and its context, planning the EMS, supporting the EMS with proper resources, operational control, performance evaluation, and continual improvement. (SFS-EN ISO 14004:2016.)

The standard lists practical measures for organizations to protect the environment. They include the following (SFS-EN ISO 14004:2016):

- improved efficiency in use of natural resources
- protection of biodiversity, habitats and ecosystems directly and indirectly
- climate change mitigation
- improvement in air and water quality

SFS-EN ISO 14004:2016 also lists competency requirements for personnel. ISO 14004 helps local managers and the HR (human resources) department hire competent personnel in the positions that have an effect on the company's environmental performance. The competency requirements apply to persons working under the organization's control who affect its environmental performance, including persons:

1) whose work has the potential to cause a significant environmental impact;
2) who are assigned responsibilities for the environmental management system, including those who:
    a) determine and evaluate environmental impacts or compliance obligations;
    b) contribute to the achievement of an environmental objective;
    c) respond to emergency situations;
    d) perform internal audits;
    e) perform evaluations of compliance. (See SFS-EN ISO 14004:2016, p. 105–107.)

When building an EMS, using both ISO 14001 and ISO 14004 as a guideline provides the organization with the best possible support. ISO 14004 lists the competency requirements and the resources needed, while ISO 14001 lists the modules that will be needed to create an EMS. Without utilizing the checklists of ISO 14004, the organization may end up with an incomplete set of resources for ISO 14001 maintenance and certification.

2.4.3 EMAS

The European Community Eco-management and Audit Scheme (EMAS) is based on the EMAS Regulation (EC) No 1221/2009. EMAS is advertised to be the most credible and robust environmental management tool on the market. It presents the same basic requirements with ISO 14001, adding several elements on top of them. The main focus and objective of EMAS is the continual improvement of environmental performance of the organization, whereas the main focus of ISO 14001 can be said to be the continual improvement of the environmental management system itself. (European Commission 2011.)

Even though EMAS is managed by the European Commission, it is also available for sites outside the European Union with certain restrictions. It has been created for the companies and organizations of the private sector and public administration that cause environmental impacts with their activities. The EMAS organization commits itself for the constant improvement of its environmental performance, that is, mitigating the environmental impacts. (European Commission 2011.)

The EMAS system consists of an environmental management system according to the ISO 14001 standard and of a separated environmental statement that must be accessible to the public. EMAS includes verification of the management system and validation of the environmental statement by an accredited or licensed EMAS verifier. After verification, the organization may apply for EMAS registration. Both EMAS and ISO 14001 include a full management system audit on a three-yearly basis. In addition, the EMAS environmental statement has to be validated once a year. (Edwards 2001; European Commission 2011.) The structure of EMAS is described in figure 2.

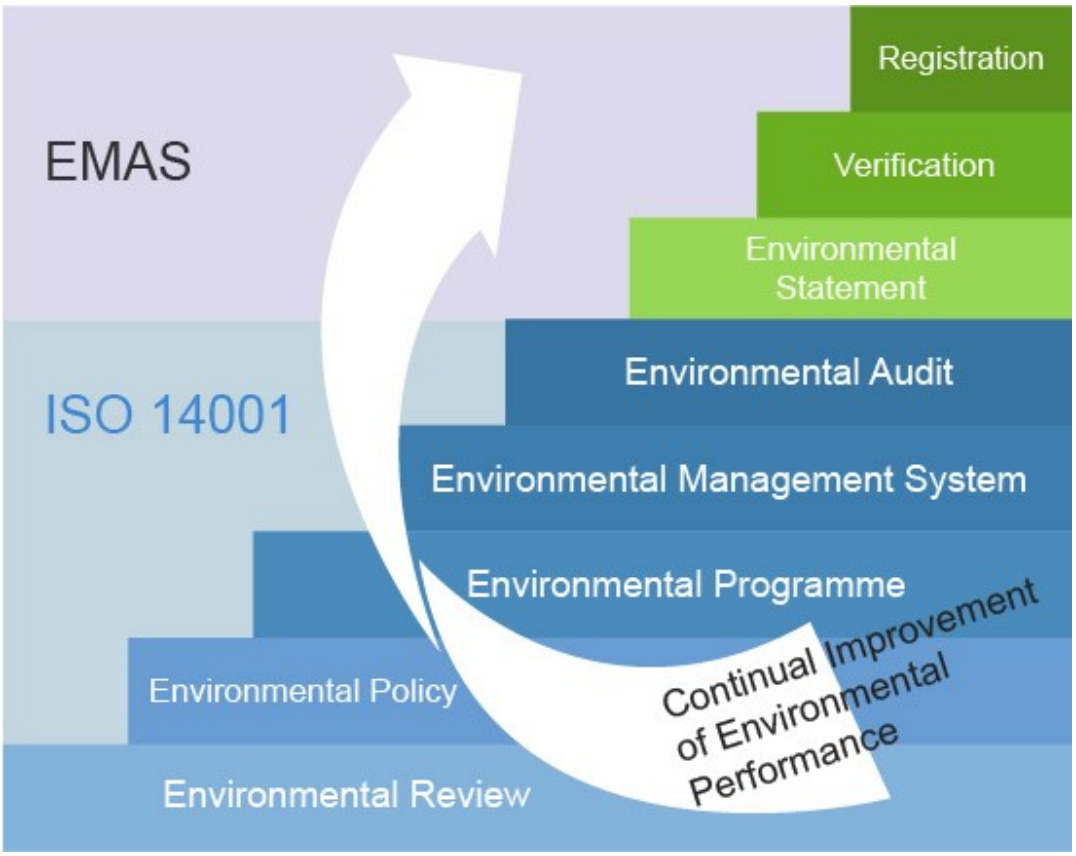

Figure 2. *The stages of acquiring a certificated environmental management system according to ISO 14001 and EMAS. The first five stages are the same in both standards. (Finland's environmental administration 2016.)*

In Finland, environmental management is officially covered in the Act on Voluntary Participation in the Eco-Management and Audit Scheme (121/2011). The fees for EMAS registrations in Finland are based on the Decree of the Ministry of the Environ-

ment (1580/2015). EMAS organizations registered in Finland are publicly listed on Ymparisto.fi, the joint website of Finland's Environmental Administration. (See Finland's environmental administration 2016.)

2.4.4 Environmental programs

Environmental management programs and environmental programs are environmental development projects and processes within a limited time frame. The program can be, for example, a one-time operation to fix something or a repetitive process to include environmental sustainability in decision-making and everyday actions.

In ISO 14001:2004, creating environmental programs within the environmental management system was included as a separate requirement in the subclauses. However, the new standard, ISO 14001:2015, does not specify requirements for environmental programs. Instead, it only specifies environmental objectives (subclause 6.2.1) and planning actions to achieve environmental objectives (subclause 6.2.2) (see SFS-EN ISO 14001:2015, p. 81). Company-wide environmental programs can still be used when needed, but active programs with a certain time frame are not a certification requirement anymore.

2.5 Environmental risk management

Environmental legislation and voluntary improvement activities have led to a healthy situation where normal, continuous emissions from manufacturing processes are today well controlled in industrial operations. In Finland, comprehensive environmental risk analyses including also accidental emissions have been performed since the 1980s, other environmental risk analyses even longer. (Wessberg et al. 2007.)

Wessberg et al. (2007) studied how well environmental management methods regarding especially accidental emissions are known in Finland. Risk terminology and industrial safety and site-specific risk analyses were found to be well known among safety authorities, safety consultants, and industrial companies. However, environmental authorities, environmental consultants, and environmental certification bodies were not equally familiar with them. The study concluded that environmental risks coming from industrial operations in their normal state are, in general, known and controlled well enough. However, assessing the risk level of accidental emissions in abnormal situations has often got less attention.

The ISO 14000 series introduces the concept of risk management in environmental management. ISO 14004 also gives several detailed examples of typical environmental risks. The main concept is risk management. Environmental risk management is a subprocess of risk management. It consists of two parts: 1) environmental risk analysis and

2) risk reduction and control. The environmental risk analysis contains the following parts:

1) Scope definition
2) Risk identification
3) Risk estimation: the probability times the severity of the consequences
4) Risk evaluation
5) Proposals for actions

The third and the fourth step are often called risk assessment. The fifth step can be considered the most important part of the analysis because it determines the practical outcome of the analysis. The fifth step also requires the deepest technical knowledge about both the company's current manufacturing processes and the alternatives available on the market. The development and investment budget has to be well known at this point. After the environmental risk analysis has been performed, risk reduction and control is a continuous PDCA process until the next update of the analysis.

Risk assessment is always group work (see for example Edwards 2001). The group needs knowledge about the company and its operations, existing technologies and chemicals, and the budget and the other resources realistically available. Only a competent group can find the solutions that lower the risks "as low as reasonably achievable" (the ALARA principle) or "as low as reasonably practicable" (the ALARP principle). (See for example International Organization for Standardization 2017.)

Understanding the relationship between cutting costs and minimizing environmental risks is especially important in environmental management. Environmental managers often face demands of cost cutting because environmental management is closely related to eco-efficiency management and energy saving activities. However, investments are often needed to prevent environmental accidents. Thus, it is also important to understand the difference between continuous emissions and accidental emissions. The potential consequences of continuous emissions and environmental accidents should be assessed separately. (See for example Wessberg et al. 2007.)

There are several standards that inform risk assessment and corporate risk management in general. ISO 31000:2009 *Risk management – Principles and guidelines* is a risk management standard that provides general principles and a process for managing all kinds of risks. It also provides guidance on how that process should be integrated into the decision-making processes of any organization. It can be used as a guideline by any organization regardless of its size, activity or sector, but it cannot be used for certification purposes. (International Organization for Standardization 2017.)

2.6 Change management and leading the change

A skillful environmental manager is a change management expert and a change leader. Environmental management is a field that is and will be under constant change, due to technological development and the overuse of natural resources. Strong change leadership is needed because knowledge alone is not enough to change habits.

One of the most well-known organizational change management theories is Lewin's Three-Step Change Model: unfreezing – change movement – refreezing. First, the status quo, the existing state of affairs, has to be unfreezed. Skillful change leaders create a sense of urgency, create a change movement, and finally refreeze the new status quo by demonstrating the relationship between the new habits and or success of the organization. Throughout the change, the leader empowers others to act on the new vision by actively removing barriers to change, encouraging risk taking, and encouraging creative problem solving to reach the goals. (See Robbins & Judge 2013, p. 584–587.) It is important to notice that a change leader needs the resources of a leader to make the change happen. The act of empowering is not all about personal skills and courage, but also about the resources given to the leader by the organization. Only a leader with resources can forward the resources.

The PDCA development cycle model found in ISO 14001 and several other management standards within the field of environmental, occupational safety, and quality management, has been criticized for its insufficient capability to generate the sense of urgency (see for example Marsh & Perera 2012). The sense of urgency is an important concept in change leadership literature, but the PDCA model doesn't support the organization in emphasizing the urgency of solving environmental issues. In some cases, environmental damage is irrecoverable or the recovery process is extremely slow compared to the time needed to cause the damage. This means that the PDCA cycle should not be the only development management model utilized in environmental management. It is essential for the change leader to also know the basic of social psychology.

Ronnenberg et al. (2011) studied the role of change management in environmental management system implementation. The study concluded that change management efforts indeed appear to enhance the perceived environmental performance. Top management should primarily drive the change management efforts. Top management should offer enough ideological support and practical resources for EMS implementation and institutionalizing the new EMS. The high importance of change management in successful EMS implementation was estimated to be generalizable to all large manufacturing facilities implementing an environmental management system. The study was conducted by using a perception measure as a dependent variable because actual environmental performance measures were not available. Using actual, mathematically calculated environmental performance measures might provide more reliable results. However, understanding the way ordinary employees observe environmental performance can also be

valuable. Mathematical data does not necessarily encourage excitement and involvement in the change process. Asking the employees how much positive development they have seen recently forces people to pay attention to the signs of development in their own work environment.

Implementing an environmental management system requires cross-functional working. Lack of cross-functional nature of working in the company is a barrier for effective organization during the implementation of the newly created EMS. Employees whose work may have an environmental impact should not be separated from each other. Top management should provide enough resources (such as working hours free from other tasks) for productive cooperation. The EMS should not be created by an external or temporary employee who will leave the organization afterwards. This kind of an arrangement easily leads to a lack of employee involvement. However, outsourcing the EMS audits from a reliable external source may be good idea. Internal auditors may have weak environmental audit skills, especially in the beginning. Incompetent auditing is a time-consuming activity that doesn't add any real business value. (Balzarova et al. 2006.)

It is important to understand the concept of *planned* change. All organizations should actively seek to improve the ability of the organization to adapt to changes in its own environment. Employee behavior has a crucial role in all changes. Change is rarely an accidental occurrence. *Change agents*, innovative employees who see a future for the organization that others have not yet identified, often fuel the change. They are able to motivate, invent, and implement the new vision that they have seen before the other employees. Change agents can be managers or nonmanagers, old or new employees, or even outside consultants. (Robbins & Judge 2013, p. 580.)

2.6.1 Environmental management maturity

Moutchnik (2015) has analyzed the most typical stages of corporate environmental management maturity. According to this theory, mature environmental management is fully incorporated into both the corporate management and the operations management in the company. Immature environmental management is mainly characterized by the absence of formal documentation. Within a single corporation, it is normal and even typical that not every part of the corporation is on the same maturity level.

The stages of environmental management maturity are (Moutchnik 2015):

1. **Basic** level
2. **Standardized** level
3. **Automated** level
4. **Continually improved** level

The transition from one stage to another can only take place after enough competence at a lower stage has been achieved. In the beginning, every corporation, and company within the corporation, is on the first level. However, even corporations with complex organizational structure can still implement only basic level environmental management strategies, even if they are otherwise in an advanced stage in their development. (Moutchnik 2015.) Table 1 describes how environmental management is connected to corporate management and how deeply it affects general operations management.

Table 1. *Stages of corporate environmental management maturity according to Moutchnik (2015).*

Stages of maturity ↓	***Types of management*** →	**Corporate Management**	**Environmental Management**		**Operations Management**
I		**basic**	reactor	monitoring	able to be disciplined
II		able to be **standardized**	benchmarker	continuous monitoring	able to be coordinated
III		able to be **automated**	integrator	database	able to be forecasted
IV		able to be **continually improved**	innovator	parameter for optimization	able to be analyzed

Corporate environmental management on the lowest maturity level, the basic level (stage I), is mainly occupied with the monitoring of environmental aspects of manufacturing operations. Monitoring is only carried out by HSE or sustainability related departments or employees, not by the managers of the operations. This kind of monitoring is selective and not continuous. (Moutchnik 2015.)

On the *basic* level (stage I), environmental regulations are often fulfilled through implementation of either “end-of-pipe” or other “add on” technologies without improving the manufacturing process (Tabor 2014). Traditionally, corporations only wanted to do the least amount of work required to avoid legal actions and fines. However, nowadays with the increasing complexity of production processes and environmental regulation, simple *end-of-pipe technologies* may not be efficient enough anymore. It is nowadays essential to optimize every part of the production process. Increased technological complexity means that there are more independent variables in a certain production process than ever before. This change has motivated creating continuous monitoring processes

also for environmental parameters to understand their causal connections better (stage II).

Collecting environmental data systematically characterizes the *standardized* level (stage II). On the *automated* level (stage III), actions that protect the environment can be automated based on the data collected in the databases. The causal connections and the resources needed to reach a certain development level are known well. It is possible to forecast the development that can be obtained with certain resources. This way, environmental management can be adjusted in all circumstances based on the data collected earlier. (Moutchnik 2015.)

On the highest level (stage IV), environmental management can be continually improved by using known parameters for optimization. These parameters were found on the automated level. On the highest level, the state of environmental management is regularly analyzed. The development plans are not focused on deficiencies anymore, but benefits. Proper amalgamation of environmental issues into general management at every level of corporate hierarchy enables the corporation to look for solutions that can make environmental protection also economically profitable. (Moutchnik 2015.)

2.6.2 Defensive and supportive environmental identities

Corporate environmental orientation is a two-dimensional construct that describes the attitude of the whole organization towards environmental issues. It consists of internal environmental orientation and external environmental orientation. Internal environmental orientation reflects the managerial perceptions of the general importance of environmental issues facing their firm. External environmental orientation reflects the need and urgency to respond to external stakeholders. (Banerjee 2002.)

On personal level, the environmental orientation of a person can be described by the concept of environmental attitude. Environmental attitude consists of values and beliefs concerning the importance of environmental issues. Different employees can have noticeably different environmental identities, even if their title or role in the organization is the same. One way to categorize environmental identities is to first recognize the main professional orientation behind the development of the attitude. The attitudes and then divided into two categories, defensive and supportive identities (table 2). (Cherrier et al. 2012.)

Table 2. *Defensive and supportive environmental identities, categorized by the main orientation type (Cherrier et al. 2012).*

Three approaches to corporate environmentalism	**Defensive identities**	**Supportive identities**
The strategic approach: **economic orientation**	**Pragmatist:** Expresses doubt about environmental sustainability, is financially minded and fears uncertainty.	**Technocentrist:** Identifies practical gains of environmental sustainability, is financially minded and identifies resource and financial savings from environmental initiatives.
The paradigm shift approach: **environmental orientation**	**Traditionalist:** Resists environmental sustainability and identifies how it conflicts with organizational objectives.	**Holist:** Approaches environmental sustainability at a holistic level and discusses sustainability in terms of personal and organizational values.
The stakeholder approach: **social orientation**	**Observer:** Observes and commentates change within the organization. Identifies supporters and resisters of change.	**Ecopreneur:** Takes on responsibility for the future generation and considers themselves to be a custodian of the natural environment.

According to one study, there is likely to be continued resistance to the environmental sustainability agenda in those organizations where environmental sustainability might be at odds with the organization's primary mission (see Cherrier et al. 2012). If the organization struggles with reaching its sustainability goals, changing managers' and employees' environmental attitudes can provide a solution.

In the light of the theory on defensive and supportive environmental identities, it is worthwhile to consider how easily existing ideas and attitudes spread in a group after a certain tipping point has been reached. According to one study, the percentage of committed opinion holders required to influence a society is approximately 10 percent only, regardless of how the new opinion starts to spread in the society. The percent of committed opinion holders required to shift the majority opinion is not dependent on the type of network or workplace. When the number of committed opinion holders is below 10 % of the population, there is no visible progress in the spread of these ideas. The

time that the minority ideas would need to become majority ideas is comparable to the age of the universe. However, if the number of committed opinion holders once grows above 10 %, the idea starts spreading fast and the minority opinion can eventually take over the original majority opinion. (Xie et al. 2011.)

3. CASE COMPANY AND RESEARCH STAGES

This thesis only covers local environmental management. Thus, it is important to understand the background of the case company, Metso Minerals, and the case factory that is located in an industrialized area only 1,0–1,5 kilometers from Tampere city center in Finland. Environmental HSE work at Metso Minerals is based on the strong sustainability approach of Metso. This chapter describes the sustainability guidelines, targets, and reporting practices from HSE perspective. As described in the previous chapter, environmental management is a wide area of management that cannot and should not be separated from other management activities. The aim is to use a research strategy that allows several rounds of iteration if needed.

3.1 Metso Minerals as a company

Metso is a world leading industrial company serving the mining, aggregates, recycling, oil, gas, pulp, paper and process industries with net sales of about 2,9 billion euros in 2015. Metso is listed on the NASDAQ OMX Helsinki, Finland. Metso currently manufactures mining and aggregates processing equipment and systems and industrial valves and controls. It also has a global network of service centers that offers a wide range of maintenance and life cycle services. Metso operates in more than 50 countries and employs more than 12 000 people. (Metso 2016a.)

Metso aims at helping its customers improve their operational efficiency, reduce risks, and increase profitability. Metso's mission is to "contribute to a more sustainable world by helping our customers to process natural resources and recycle materials into valuable products." The most important assets of the company are its experienced personnel with unique knowledge and innovative solutions for building new, sustainable ways of growing together with the customer. Metso's values are Driving Customer Success, Seeking Innovations, Performing Together and Respecting Each Other. Metso has an uncompromising attitude towards safety. (Metso 2016a.)

Metso Minerals Tampere factories, locally known as Lokomo, is the company's most important global competence center for mobile crushers. Metso Minerals Inc. manufactures mining and aggregates processing equipment and systems, such as crushers and mobile crushing plants. The Lokomo factories have been operational since 1915 (Törmä 2015, p. 10). The main product designed and manufactured in Tampere is the mobile crushing plant. More than 7 000 mobile crushing plants have been manufactured at Lokomo over the timespan of 30 years. (Metso 2015.)

There are nowadays approximately 700 employees working for Metso at Lokomo in Tampere in the 17-hectare industrial area of Lokomonkatu 3. (Metso 2015.) Residential areas surround the area, the other neighbor being an industrial company with an R&D facility and office premises, the other a state office. Rind behind the premises, there is a highly trafficked state railroad. In front of the premises, there are highly trafficked streets. The distance to the edge of the city center area of Tampere is only 1 kilometer. See Appendix A for a map of the factory area.

In April 2015, the foundry business and the foundry properties located on the same premises were officially transferred from Metso Minerals to another company, Tevo Lokomo. The business was sold, but the premises were only leased. Lassila & Tikanoja (L&T) continued delivering facility management and environmental services to both companies.

3.2 Research strategy and tasks

This thesis consists of a qualitative research study, internal company documents, and this report together with public appendices. The research steps are described in Figure 3.

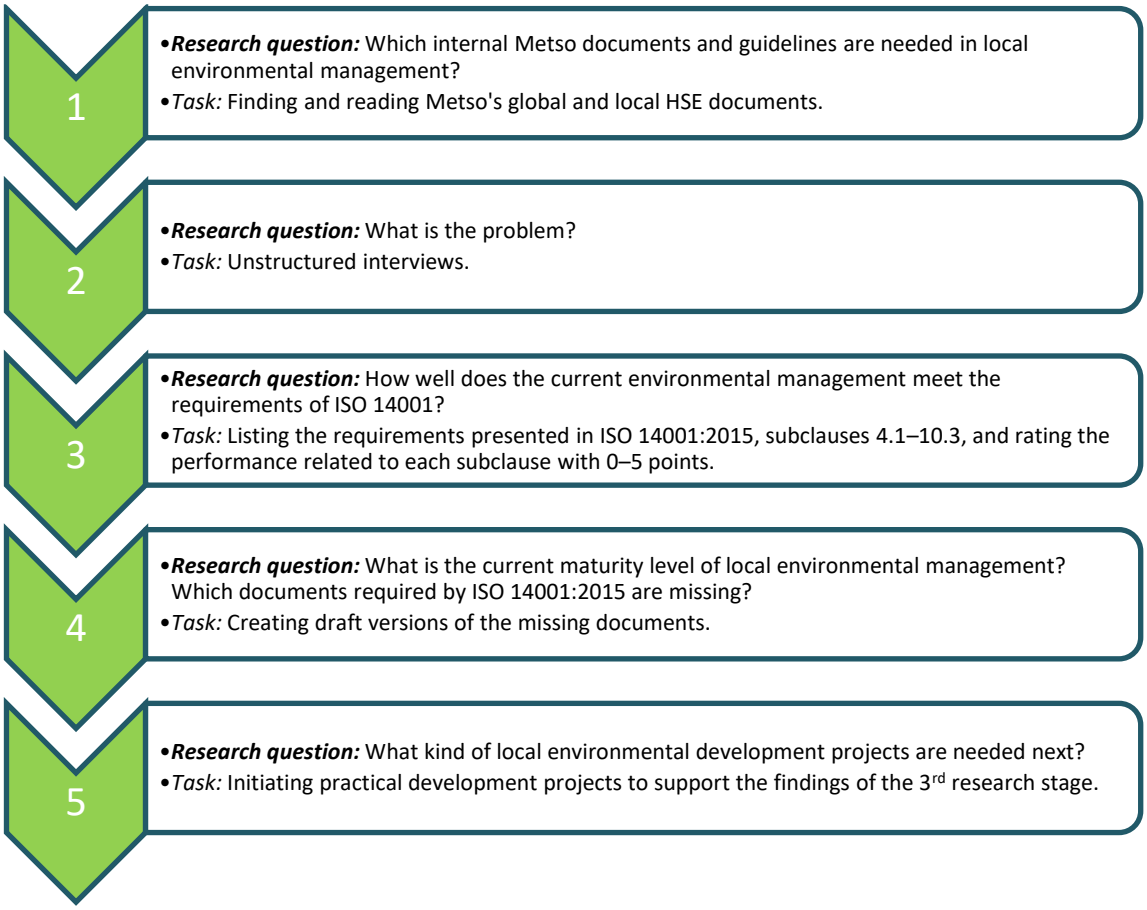

Figure 3. *The research stages of this thesis project, as described by the research question and the research task of each stage.*

The project begins with interviews to find out why the company doesn't currently have an EMS and what kind of organizational obstacles there might be for implementing a new EMS efficiently. The interviews are unstructured, informal and possibly also partly unscheduled to hear honest opinions instead of formal goals. The main interviewees include:

- The Operations Development Team, including the local HSE Specialist
- The local Green Office group
- The local maintenance employees
- The site manager (vice president of operations)

Based on the interviews, the most important internal Metso HSE documents will be gathered for further analysis and a list of relevant regulations will be created to support future environmental management. The current state of local environmental management will be compared to the ISO 14001 standard clause by clause. The target is to find deficiencies that refer to a missing part or inadequate way of action. Drafts of management system documents are then created to build up a comprehensive framework for local environmental management and development work. When existing Metso documents already cover a clause of ISO 14001, new overlapping documents won't be created to avoid confusion in future audits. Also the aspects mentioned in the delimitations in Chapter 1 will be left out. This way, the organization can see and track the benefits of having an environmental management system while implementing the system step-by-step, adding or expanding only elements that provide value to the organization (see SFS-EN ISO 14001:2015, p. 129–130).

To support the implementation of the EMS, minor development projects will be initiated based on the environmental aspects and environmental risks found during the project. Project management of these projects is not in the scope of this thesis. Eligible development project managers will be appointed with the help of the factory steering committee.

4. RESULTS

The current state analysis is based on ISO 14001:2015. Development proposals are presented and prioritized based on the assumption that the most important need of the organization is to act according to environmental legislation. In 2016-2017, the organization was not aiming for a third-party certification.

Some development tasks were already started during this thesis. This chapter presents them and their meaning for the local environmental management. This thesis project also produced certain environmental management system document drafts. They were written in Finnish in order to make environmental management reachable for everyone in the local organization. This chapter introduces them shortly and describes why the procedures established in them will have to be adopted.

4.1 Environmental sustainability at Metso

Metso's sustainability strategy is divided into four main focus areas to support the business strategy: 1) building customer success, 2) performing together, 3) contributing to the environment and 4) responsible supply chain. As a part of the official annual report, Metso publishes an extensive sustainability report. (See Metso 2016a and Metso 2016b.) The 2015 report presents Metso's sustainability approach based on the Global Reporting Initiative (GRI) G4 Sustainability Reporting Guidelines (table 3).

Table 3. *Metso's 2015 sustainability topics compared to the G4 guidelines (Metso 2016a).*

Top Metso sustainability topics 2015	**GRI G4 Material Aspects**
Customer partnership	Product and service labeling
Health and safety	Occupational health and safety
Human rights in operations	Non-discrimination, Anti-corruption
Sustainable technology	Customer health and safety
Responsible supply chain	Economic performance
Eco-efficiency of own production	Energy, waste, emissions, effluents and waste
Employee engagement	Employment, Labor/management relations, diver-
Leadership and competence development	Training and education

The table shows that environmental sustainability is only one part of Metso's wide sustainability approach. Environmental sustainability is especially taken into account re-

garding eco-efficiency in Metso's own production and sustainable technology. Figure 4 presents Metso's public sustainability targets and action plans.

Focus area	Sustainability targets and action plan 2016-2018
Building our customer success	• All the new R&D* projects have to set environmental efficiency and product safety innovation targets (if applicable) as of 2016 and verify the results when the project is closed. Solid verification development • More focused customer engagement and Metso responsiveness on sustainability development • Brand awareness; Metso is well known for its sustainability perfomance and capabilities
Performing together	• LTIF* <1 • Human rights impact assessment conducted, action plans for corrective actions made, and Metso employees and relevant partners trained • Code of conduct updated, all employees trained and all the relevant partners informed • More focused stakeholder engagement and responsiveness • Employee engagement surveys done regularly and related actions done in teams • KPIs* to track social benefits for the major sponsorship projects
Contributing to the environment	• Water reduction target for each unit in 2016 and 15% in total by 2020 • Waste going to landfill reduced by 15% by 2020 from 2014 level including yearly targets • Energy saving and CO_2-emissions reduction targets for each unit in 2016 and 20% in total by 2020 • All production units have to conduct environmental audits with Metso audit tools • Zero environmental accidents • All employees receive environmental training • Externally assured CO_2 levels of procurement, logistics and business travel
Responsible supply chain	• Third-party sustainability audits for high- and medium-risk supplier base, minimum 15 per year • Established sustainability follow-up tools and processes: - 100% of new suppliers in high-risk areas screened on sustainability issues - Existing high- and medium-risk supplier base screened on sustainability issues • Procurement personnel trained on sustainability • Compliance with chemical legislation and restricted materials through systematic qualification process

*R&D = Research and Development *LTIF = Lost Time Incident Frequency *KPI = Key Performance Indicator

Figure 4. *Metso Corporation has clear sustainability targets and action plans (Metso 2016b).*

Metso's global environmental policy can be found in both the internal and in the public sustainability material on the intranet and on the corporate website. The policy has been almost the same for many years. In 2016, Metso's environmental policy commanded (Metso 2016c):

"Metso Corporation contributes to sustainable development through all its activities. - We anticipate the environmental concerns of our customers and the expectations of the public. We cooperate with our customers and partners to develop best practices and processes to improve the efficient and sustainable use of energy and materials as well as to prevent pollution. - We are aware of and responsive to environmental risks and opportunities. We comply with environmental legislation and anticipate its development. We are committed to the principles of the sustainable development in accordance with the ICC (International Chamber of Commerce) Business Charter. - We implement environmental management practices in accordance with the ISO 14000 standards, and strive to make the utmost use of best practices and synergies between our businesses. We are continuously improving the environmental performance of our operations and the know-how of our personnel. - We network actively with our key stakeholders to sup-

port our environmental management. We communicate actively and openly about environmental issues, their targets and results, both internally and externally."

The environmental policy has been signed by the Chief Executive Officer of Metso Corporation. Metso also has specific Criteria of Sustainable Development for Suppliers. One part of the Partnership Criteria is *the protection of the environment and the abatement of climate change: all Metso's suppliers shall strive towards reducing the use of raw materials and energy as well minimizing waste and emissions*. That part of the partnership criteria includes the following requirements (Metso 2016d):

1. The supplier shall recognize the environmental impacts and risks related to their operation and create an action plan for managing risks and reducing adverse environmental impacts.
2. Waste shall be appropriately sorted and forwarded on to be utilized or recycled as far as possible. Toxic waste shall be forwarded to appropriate processing.
3. Substances hazardous to the environment or health shall be identified, and it shall be ensured that their use, storage, and disposal are performed in a safe and controlled way. Safety data sheets and instructions for eventual accidents shall be up to date.
4. Raw materials, water, and energy shall be used efficiently, and constant effort shall be spent on optimizing their use.
5. Emissions to air, water, and the ground shall be minimized.
6. The supplier shall ensure that all environmental permits required by the operations are up to date and that the operational and reporting requirements included in them are observed.
7. The supplier shall comply with environmental legislation and official regulations, as well as anticipate changes in them.

Metso celebrates *Environmental week* internally once a year. During the week, a new environmental sustainability related topic is presented every day together with small photo contests. The environmental week aims to spread environmental sustainability knowledge among all employee groups globally.

4.1.1 Metso's HSE regulations and instructions

Metso HSE Policy is the statement that forms the basis for all HSE work at Metso. It states the following guidelines that are binding for every employee and decision made at Metso (Metso 2015):

- We are committed to take personal responsibility for our health and safety.
- We believe that all injuries, environmental incidents and health hazards can be prevented.

- We strongly promote a safe and healthy working environment and the well-being of our employees.
- We always emphasize our high HSE standards of conduct when dealing with customers, suppliers and other stakeholders. Compliance with applicable laws and regulations is only a minimum requirement.
- We aspire to minimize our environmental footprint throughout the value chain.

Everyday HSE work at Metso is based on the **Metso HSE Manual** (figure 5). It is available as separate intranet pages and files internally.

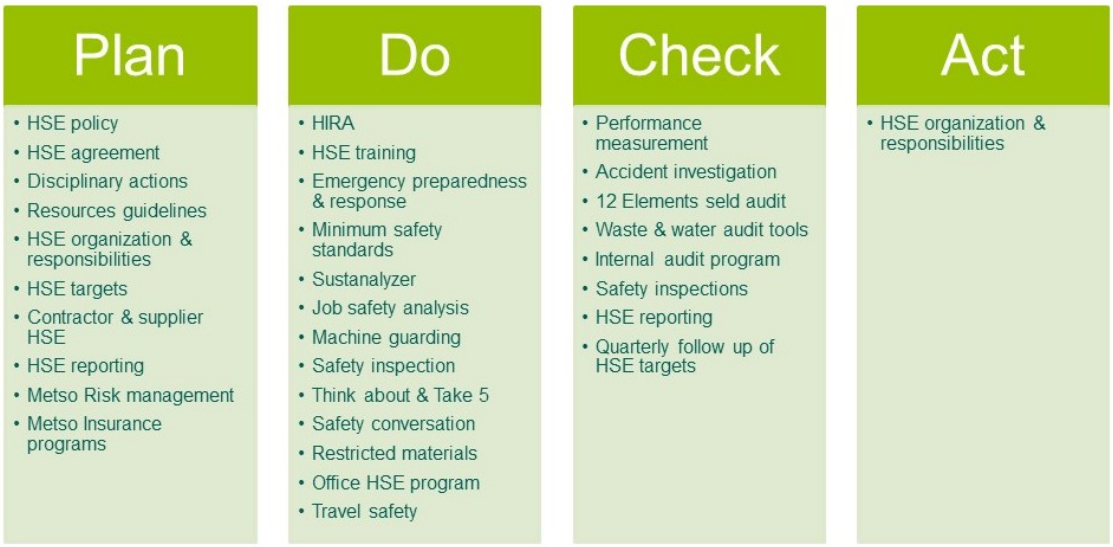

Figure 5. *A screenshot of the contents of the Metso HSE Manual that is available for all employees with access to the intranet.*

The HSE Manual describes the Metso way of HSE management and HSE procedures. The manual consists of four chapters:

1) **Plan** – Manage HSE
2) **Do** – Execute HSE
3) **Check** – Monitor HSE
4) **Act** – Adjust and improve HSE

The Contents list and the Toolbox support the PDCA structure. The contents give a quick view on what an HSE employee working at Metso should know. The intranet also covers non-HSE employees' responsibilities regarding HSE incidents.

All HSE-related incidents must be reported in Sustanalyzer, the new HSE reporting system. Sustanalyzer replaced the HSE Monitor in 2015. The HSE Monitor is still available as a data archive. Reporting on paper and leaving the form in a post box should also be possible in each location. Anonymous reporting on paper is obviously possible but not encouraged in the instructions.

Metso HIRA is an important part of the Metso HSE Manual. It forms the basis for local HSE work. HIRA is the process used at Metso for identifying hazards and assessing risks related to health, safety, and the environment. According to the internal HIRA Guideline document, the HIRA process is supposed to produce the following outcome:

- Identification of hazards: health, safety, and environmental hazards
- Assessment of related risk
- Prevention of unwanted events related to each risk
- Prevention of reoccurrence if already too late
- Input for employee training, job descriptions, and instructions, ensuring each job can be performed in a safe way
- A safe working environment and an environmentally friendly business model

The former *12 Elements* HSE self-audit model (see figure 4) is also available internally as support material. It contains practical questions that sites can use to self-evaluate their environmental management and awareness. The model is Metso-specific and does not fully cover the topics of ISO 14001:2015. It has not been updated recently, but answering the self-audit questions can still give new ideas to local environmental management.

4.1.2 Metso Energy Efficiency Program (MEEP)

In 2010, Metso's global Energy Team established the Metso Energy Efficiency Program (MEEP). MEEP set global, group-wide targets for energy conservation and carbon dioxide emissions considering Metso's own production. The global target is to reduce Metso's energy consumption and CO_2 emissions (carbon dioxide emissions) by 15 percent by 2015 and by 20 percent by 2020 compared to local business volume each year. The global water reduction target is to reduce Metso's water consumption by 15 percent by 2020. The first actual targets were set based on the corresponding levels of 2009. The exact targets are calculated and set locally each year, mainly based on the previous years' development but also on the funds available. (Niemi 2016.)

MEEP does not directly finance all MEEP-related development plans. However, to be able to receive financial support from corporate level, the plants have to write down their development plans and financial needs in the form of a MEEP Investment Proposal. The global energy team then grants support to viable projects. In general, the plant will still have to cover most of the costs. This model ensures that the limited resources available are spent wisely. Due to the fact that the development and investment resources are not unlimited, there are no penalties for the plants that don't reach their targets by the end of the year. (Niemi 2016.)

Figures 6 and 7 show that MEEP has been successful in decreasing both Metso's production sites' CO_2 emissions and Metso's general energy consumption. Also, the water

consumption reduction has been similarly successful. The Tampere factory has also reached its yearly targets well. By 2016, Tampere had reached the halfway point of the 2009–2020 savings.

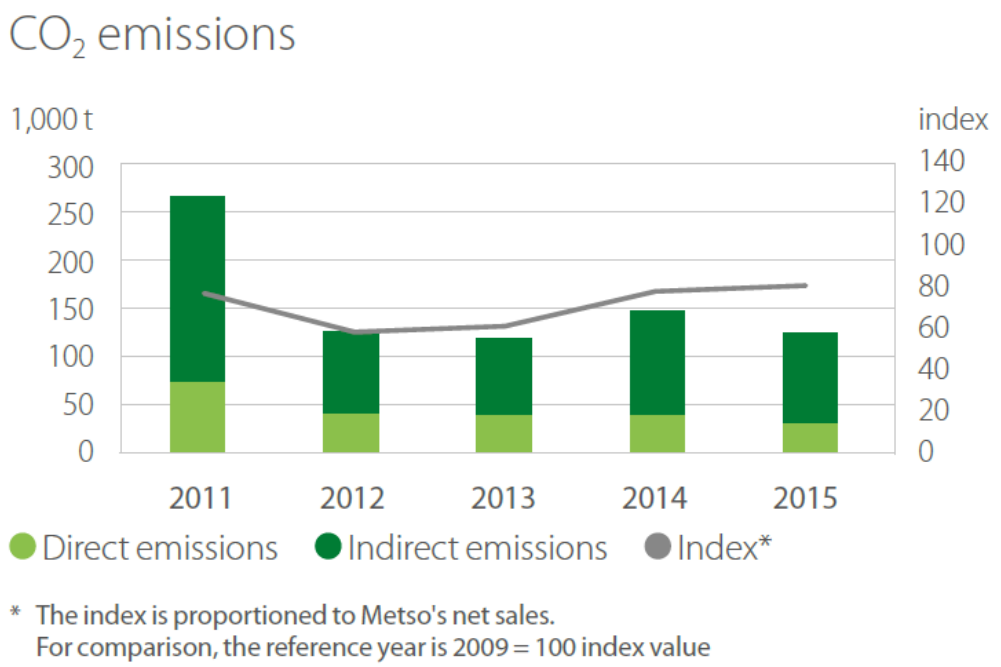

Figure 6. *The development of the CO_2 emissions of Metso's own production (Niemi 2016).*

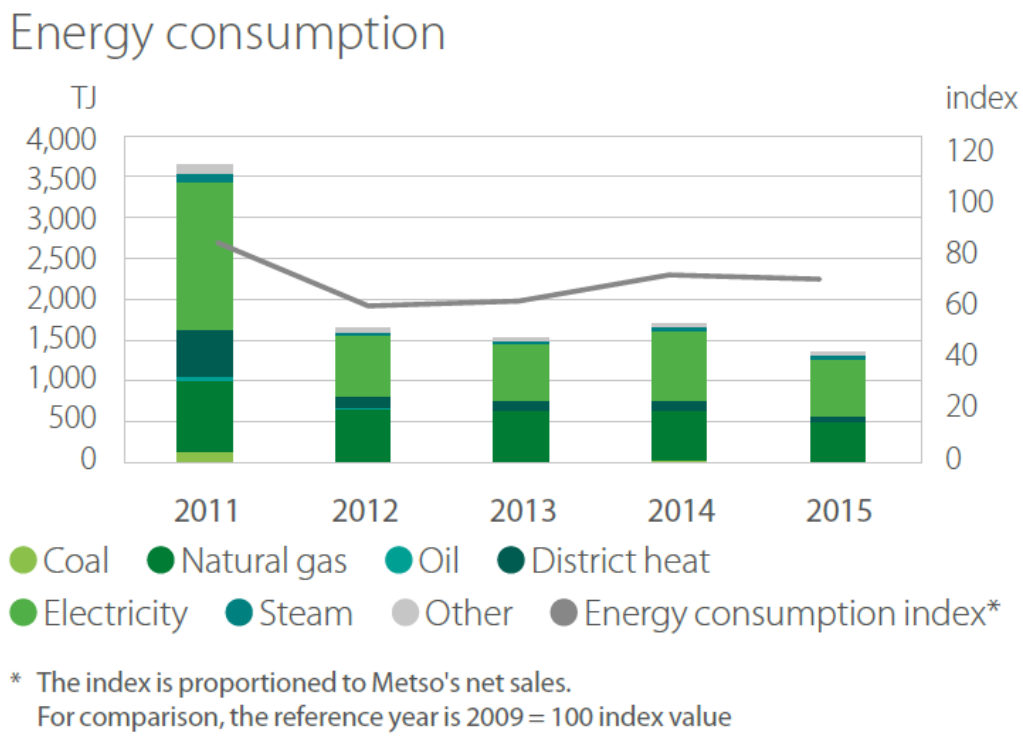

Figure 7. *The development of the primary (direct) energy consumption at Metso (Niemi 2016).*

MEEP investment proposals have been collected in the MEEP Investment Proposals database. The proposals for Metso Minerals Tampere are the following:

- Compressed air
- Heating and cooling of buildings
- Lighting
- Ventilation
- Water
- Product painting process
- Car parking sockets

The global energy management systems standard, ISO 50001, could potentially offer further ideas and guidelines for energy and cost savings. Also, the future plans of the other locations could be requested in a written form if they cannot be found in the MEEP database.

The MEEP database has been actively updated until late 2011. After 2011, the database has not been in active use. In Tampere, the MEEP targets have been set by the local maintenance team, not by HSE personnel. The local HSE function has not participated in MEEP planning. Together with the Metso MEEP, the Finnish Metso plants (Tampere and Vantaa) have also participated the Finnish EED energy efficiency agreement system. The local maintenance team has also set the EED savings targets. The EED targets have been binding, so the local MEEP targets have been set based on them.

4.1.3 WWF Green Office program at Metso Minerals in Tampere

WWF Green Office is “a practical environmental management system for offices”. The Green Office program aims to help all kinds of offices reduce their ecological footprint and greenhouse gas emissions. It works as a support system for motivating the office staff to act in an environmentally friendly way. This way, it also brings cost savings and benefits both the organization and the environment. The joining organization supports WWF’s nature conservation work with an initial fee and an annual fee, both based on the number of employees in the office. One company can enroll several offices. That alters the fee, but otherwise each office works as an individual member of the Green Office network and can plan all actions independently. (WWF Finland 2014a; WWF Finland 2014b.)

Metso Minerals Tampere office signed a contract with WWF Finland in 2014 (Metso 2014b). Only the main office (“keskuskonttori”) building on Lokomonkatu was officially enrolled into the program. The other offices, including the offices that belong to the factory organization for which this thesis is written, were not officially enrolled. The Green Office team was formed by a coordinator and three team members. None of the members were full-time sustainability or HSE specialists, but as a team, they had long-

term experience of both office assistant task and maintenance planning. By the beginning of 2017, only one member of the team has changed.

Green Office network extranet, WWF Compass, is a platform for planning Green Office activities. Each office must create its own annual environmental program within the Green Office program. The program is supposed to focus on practical targets and people's daily working habits at the office. Informing and educating personnel about green office practices is an important part of the program. (WWF Finland 2014b.)

Each office must report to WWF annually, in March. When signing the contract, the office must choose at least three Green Office indicators to be monitored. Within the program, the office then should reach at least a 5 % saving off each of the targets. (WWF Finland 2016.) Metso Minerals chose the following indicators and saving targets for Tampere main office in 2014 (Metso 2014a):

- Electricity consumption: -5 %
- Heat from the district heating network: -5 %
- Waste: -5 %
- Water consumption: -5 %
- Paper consumption: -5 %

The usage rate of video conference rooms and the usage rate of public transport during work trips were chosen as voluntary indicators. Paying attention to green issues in office item procurement is a requirement from WWF, but it was left out from the indicator list because it is not easily calculable. (See WWF Finland 2014b.) Metso Minerals Tampere main office reached the targets during 2015–2016 before this thesis project began. Setting further office savings targets for upcoming years was not needed within WWF Green Office.

4.2 The basis for the current state analysis

The first research task was to find out what the problem was. Why was a thesis project needed? Several informal interviews between September 2016 and February 2017 made it clear that the organization is strongly focused on safety. Occupational health and safety have been very important aspects in all HSE work everywhere at Metso. The environment has been managed side by side with practical issues like chemical usage, energy usage, and waste management. There has been no Environmental Roadmap before 2017 to guide local environmental work or planning. However, occupational safety work has been systematically planned. The safety-related responsibilities have been clear.

It was found out that the organization needs a roadmap for environmental management. Also, emergency preparedness and oil spill prevention need more attention. Employees with responsibilities related to environmental protection should be listed.

No former research studies had been conducted on environmental topics in Tampere manufacturing organization. Metso Minerals participated in a FIMECC research project in 2009–2014 regarding the future business possibilities of the life cycle assessment (LCA) of Metso products and their manufacturing processes. The results are not directly related to this study due to their very general nature regarding environmental work and focus on product aspects and product design work.

In 2008, a thesis research study was conducted on the development possibilities of local packing procedures and packing materials. That thesis was written for the Tampere distribution center that is located next to the factory on the same premises. The 2008 thesis concluded that there would be even more possibilities to reuse and recycle packaging materials in Tampere, even though some materials are already reused. (See Hakala 2008, p. 114–119.)

In 2007, a thesis research study was conducted for Metso Corporation concerning environmentally responsible procurement. The thesis recommends that all Metso plants validate environmental instructions for green procurement. General sustainability was already taken into account in Metso's general procurement instructions in 2007. However, the findings of the project emphasize that the environmental effects of different kinds of procurement decisions still need more attention. (See Jungman 2007.)

Metso Minerals Tampere production is not aiming at a third-party certificate for its local environmental system because "there is currently no customer pressure for an official certificate." During the interviews between September 2016 and February 2017, several managers expressed a strong will to better understand the "E" of HSE. Some worries regarding preparedness for environmental incidents were mentioned. Still, most managers emphasized the importance of better understanding the chances environmental management offers for operational savings due to more sustainable ways of working. The focus was mainly on planned everyday savings, but also the cleaning costs of potential environmental incidents were mentioned as a driver for sustainable development.

InstaAudit, a new online system for HSE management, had recently been purchased for local HSE work. The system had been chosen based on its ease of use. InstaAudit offers all HSE-related IT tools in an easy-to-use form in one place. All modules are available on the desktop and on mobile devices. The new chemical tool was supposed to be published during summer 2016. The implementation of the chemical tool was supposed to form a basis for this thesis around August 2016. The implementation had to be left out because of some business-related delay in the development cooperation. The system was eventually taken into test use during winter 2016–2017. As the IT system imple-

mentation part was left out, full research attention was given to the ISO 14001 current state analysis and environmental management recommendations.

4.3 Current state analysis

The following Metso documents and databases were found to be needed in researching performing local environmental management tasks:

- Avenue, the Metso Intranet
- The local SharePoint worksites (Tampere production organization; Tampere HSE worksite; the shared Metso worksite of L&T)
- Sustanalyzer (HSE incident reporting system)
- The local chemical register (first: an Excel sheet; later on: InstaAudit)
- WWF Green Office: the Compass extranet
- For reference: old audit reports
- For reference: old Lotus Notes databases
- For reference: the global HSE reports (PowerPoint files)

The current state analysis based on the requirements of the standard ISO 14001:2015 is presented in Appendix B in table B-1. The current state of the environmental management practices got **74** points out of **110** points. Each subclause of SFS-EN 14001:2015 was qualitatively compared to the current state. The performance was then evaluated by giving 0–5 points, full 5 points meaning an excellent state and fewer than 3 points meaning a non-satisfactory level. The comparison was performed from September 2016 to February 2017. The results reflect the state of February 2017.

The current state of "74 / 110 points" portrays a good starting point for a formal environmental management system. The maximum, 110 points, refers to an idealistic situation with all processes and activities prepared to deliver excellent results. However, the idealistic maximum point situation is not necessarily an ideal situation for business. The skill of environmental management is to find the correct balance between costs and benefits under current and future circumstances.

The performance related to the following subclauses received fewer than 3 points:

- Determining the scope of the environmental management system (1/5 points)
- Environmental management system (2/5 points)
- Actions to address risks and opportunities (2/5 points)
- Competence (2/5 points)
- Awareness (2/5 points)
- Documented information (2/5 points)

Actions to address risks and opportunities and *Documented information* are shortcomings with respect to legal compliance. These deficiencies need formal development

work in the near future. Especially the lack of documented HSE legislation follow-up work and documented environmental risk assessment work is alarming. These types of HSE work are required by the law. Also, according to Metso's own HIRA guidelines, each location should always have an updated list of environmental aspects and impacts and a separate environmental risk assessment document.

The current state of 74 points represents Moutchnik's (2015) second maturity level. The subsections of local HSE management have been *standardized.* Local HSE management in Tampere is characterized by active *benchmarking* both inside and outside the Metso Corporation and the Lokomonkatu premises. Local and global HSE data, local environmental incidents, everyday working methods, and the usage and storage of chemicals are *continuously monitored*. Collecting environmental data, environment-related tasks, risky jobs, and environmental maintenance and development projects can *be coordinated*.

Reaching the *automated integrator's* level, the next development stage, can only happen when the performance related to each subclause is worth at least 3/5 points. There is no scientific evidence to show which exact level of ISO 14001:2015 obedience would lead to a certain maturity level, but *forecasting* is not possible as long as documenting is insufficient. Immature environmental management is typically characterized by the absence of formal documentation (Moutchnik 2015).

In comparison, global environmental management at Metso was found to be remarkably mature. Mature environmental management is fully incorporated into both the corporate management and the operations management in the company (Moutchnik 2015). Global HSE employees and managers are able to pick *parameters for optimization* based on the HSE data available from different locations. In practice, these parameters can be, for example, MEEP funds. The development achieved with a certain amount of money or other resources can be estimated accurately. Strict Metso-specific rules can be set because the current level and the future needs of environmental management can be *analyzed*. The current environmental rules consider for example chemical handling, chemical storing, and fire safety related maintenance tasks. The Metso Corporation is globally on the *IV environmental management maturity level* (the highest level) on which environmental management can be *continually improved*. With the internal energy efficiency program, MEEP, the Metso Corporation also acts as an environmental innovator in its own field.

4.3.1 The relationship between sustainability and HSE work

According to several informal interviews around September 2016, efficient end products have been seen as an essential means of achieving environmental sustainability at Metso. This way of thinking has led to the focus being on decreasing the life cycle costs of the end products, instead of actively investigating how environmentally friendly the

current manufacturing processes and procedures are. This communicational focus can be seen, for example, in granting the internal Metso Award of 2016 to a project related to developing the environmental sustainability of a *customer's* actions. In the internal communication, the Metso-related environmental sustainability or the *internal* HSE aspects related to *executing* the project efficiently were not explained in any way.

The Investors' Page on Metso.com only mentions the followings viewpoints under the title "Sustainability risk and opportunity assessment" in the Environment part (Metso 2016e):

- *"The biggest threats and opportunities related to the environment and climate change are transferred to Metso from our customers and are thus linked to our products, technology, and research and technology development."*
- *"We assist our customers in reducing their CO_2 emissions through energy savings in their existing operations or through innovative energy-efficient technologies for new plants."*

These public points of view repeat the same message: the biggest environmental issues to be solved come from the customers. The business model is sustainable when it is focused on assisting the customers become more sustainable in their operations.

Sustainability work was found to be separated from HSE work. The local HSE personnel, the development engineers, and the local maintenance personnel had never properly cooperated with the global sustainability personnel. One of the reasons why the local HSE-related personnel had never contacted the sustainability contacts asking for help was that the global sustainability contacts known locally seemed to have a background in social sciences, rather than in engineering or natural sciences. The local dilemmas, in turn, were related to such things as replacing specific harmful chemicals with equally good but less harmful chemicals with a limited budget, planning environmentally friendly renovations and energy savings in detail, and controlling the emissions of the painting process. The local employees felt that the sustainability agenda of Metso was somewhat distant from the everyday HSE work.

The professional support of global HSE area managers was considered useful and helpful, but not necessarily frequent enough. Each geographical area where Metso operates has its own Health, Safety and Environmental manager. The current and the previous HSE manager responsible for coordinating Tampere HSE work were located in Sweden. During this project, the HSE manager visited Tampere once to support the local HSE. He did not audit the state of HSE or environmental documentation during the visit or by email at any other time.

The deciding bodies, such as the local steering committee and the separate factory steering committee, do actively welcome the HSE perspective. The HSE function is a permanent member of the local steering committee and present in all meetings. The factory

steering committee does not have a permanent member focusing on the HSE aspects of the decisions, but every committee meeting ends with a short HSE inspection in the production.

The position of the local HSE was found to be partly strong. The HSE function was regularly present in the deciding groups where it was needed. However, the actual role given to the HSE function was often commenting, “lobbying”, or training the actual decision-makers. The decisions were not made based on an HSE aspect and impact analysis. The role of HSE in decision-making was reasoned with motives such as “the importance of preventing environmental accidents and incidents from occurring.” Motives such as “making greener and wiser decisions than before” were not specifically emphasized.

Local development managers mentioned that the way of collecting environmental data possibly affects the motivation to improve what the indicators show. The monthly HSE reports published globally have very few environmental indicators or notions. The environmental indicators used locally, in turn, do not separate the production lines or buildings. The obligation to continuously develop the processes does not feel as “personal” in environmental work as it does it occupational safety work where the separation and allocation can easily be done. However, the practical difficulties of allocating for example recycling costs was understood well.

The lack of active cross-functional working was identified as a weakness (see Balzarova et al. 2006). The lack of a local HSE forum or an HSE steering committee would make implementing a proper EMS slow. Single meetings on certain HSE-related topics are not enough to ensure active cooperation between global and local HSE employees and global and local energy and maintenance employees. The communication between sustainability and HSE employees does not have to be frequent, but a connection should exist.

4.3.2 MEEP status in Tampere

Tampere had reached the MEEP targets that had been separately set each year by the local maintenance manager. The detailed information about the targets and the achievements was discussed with the factory steering committee in January and February 2017. The related files are available internally.

In late 2016, the 2009–2020 savings targets were approximately 50 % reached. The development pace had been good and balanced. The energy targets had been reached with specific investments and work equipment and building repair projects by focusing on stopping wasting energy (electricity and heat from the local district heating system). The waste targets had been reached by optimizing recycling both inside and outside the company premises and reusing more materials than before. Also, renting the foundry

business and premises to another company had most likely had a positive effect on the calculations, even if the amount of waste was always compared to the amount of production, as were the energy and water usage rates. Only in water savings the global calculation method had been changed so that the targets had been reached without specific investments. Still, several new water meters had been installed to allocate the water usage better than before. Leaking taps and toilet seats had been found and replaced.

The challenge between 2017–2020 will be finding new savings and development projects that can be afforded. The so called low-hanging fruits, the easiest low-cost development projects with the most benefits, have already been carried out. The pace of development should stay the same, but the easiest and the most cost-effective project ideas have already been used. This means that more funds will be needed than before to reach all the annual targets each year between 2017–2020.

The MEEP database of Tampere had last been actively updated around 2011. However, all the data and the plans had been saved on private computers, so nothing was actually lost. Every year, the maintenance manager had carefully reported the achievements to the global energy team. The global energy team had delivered the savings results to be shown in the public annual report. Only the original idea of MEEP, sharing the ideas and plans at an early phase and giving ideas to other locations, was lost.

In November 2015, a technical consultant company had calculated how much energy (electricity and heat) could be saved in the biggest building groups with small and middle-sized investments. The report estimates that 87 700 euros worth of electricity (637 MWh) and heat (600 MWh) could be saved each year. The savings potential in water was estimated to be much smaller, only some thousands of euros per year. The report also presents detailed plans and instructions regarding the investments and payback times needed.

To raise discussion about energy consumption and saving energy, five plug-in electricity meters were installed in the office of the Operations Development Team. The difference between the electricity consumption of the new and the old monitors and laptops and the difference usage habits was visible. Still, the small difference was not so significant that replacing the old appliances would be beneficial for the environment in any way, taking into account the natural resources needed to produce new appliances. Turning the monitors off for the night and the weekend was strongly recommended. It is possible that the laptops age faster if they are always on, and the general fire risk level is higher if the monitors are always on.

The environmental services have mostly been outsourced from L&T. The service company has one permanent employee working on Lokomonkatu 3. Due to this arrangement, the recycling reports come from L&T. This means that to change the calculation

or allocation methods, L&T has to be informed early enough and preferably also invited to join the development discussion.

Leasing solar panels was considered as a MEEP-related, green marketing and development idea within this thesis project. A few local companies that lease solar panels were contacted. The solar energy potential of the highest rooftop was analyzed. A 190 kW solar panel system was recommended by the company that was invited to visit the location. The details of the quotation are confidential. The idea and the quotation were forwarded to the maintenance manager and the local steering committee for consideration and further development. Functional evaluation was still required to support the decision-making process.

4.3.3 Environmental communication status

In Tampere, written environmental communication has been published in the following internal channels:

- Avenue, the Metso Intranet
- The local HSE worksite (SharePoint)
- Digital information screens

The important HSE-related reports, such as the global HSE reports, have been separately distributed by email to the managers who should read them. Still, these emails have never been the only information channel. Everything has also been available on the intranet.

It has recently become considerably more difficult to inform the production workers. The Avenue intranet website service has been discontinued for every user without a company email address and an Office 365 account. This means that the environmental management material that the production workers need has to be printed out and distributed to the bulletin boards and coffee rooms. The situation is still quite new, and the limitations have not necessarily been taken into account in all communication.

The following local forums have been used in environmental planning and as official deciding forums:

- Factory steering committee meetings (led by the vice president of Tampere manufacturing)
- Local steering committee meeting (led by the site manager, the vice president of operations)
- Operative steering group meetings (the maintenance employees)
- Strategic steering group meetings (the maintenance employees)
- The open factory meeting, every morning at 9 (at least one HSE topic every day)
- The everyday team meetings before the factory meeting

- The Green Office steering group meetings
- The meetings of the statutory health and safety delegates (mainly focused on occupational safety development)

The Metso-level environmental communicators are the following:

- HSE professionals (global and local)
- Sustainability and energy professionals (global)
- All general managers (global and local)
- Maintenance professionals (local)
- The statutory health and safety delegates (local)
- The internal communications specialists (local)
- The Green Office steering groups (local)
- HR (local)

During this research project, it was not easy to get personal answers from the general mailing list of HSE professionals. An email was sent to the list with the help of the moderator, asking for accurate examples of local environmental aspect and impact files. Only two HSE professionals were able to share material related to environmental aspects and impacts. Only one file was proper and up to date, so a comparison analysis was not possible. Three answers were received in total.

By January 2017, a brand-new list of maintenance and environmental contacts was distributed to every part of the factory, including every office in the factory buildings. Oral instructions regarding unexpected situations were given together with the laminated paper. Before publishing the new list, the environmental emergency contacts had been available but they had been more difficult to find.

The factory steering committee and the development managers felt that locally, the environmental attitudes of the managers are old-fashioned and not at the level Metso globally requires. However, an opinion poll was considered unnecessary in 2016–2017. Regarding local environmental management, energy savings and recycling actions were considered more useful than attitude research due to their financial benefits. Occupational safety attitudes were researched in early 2017, but environmental questions could not be included because the form was a standard form used by the cooperating insurance company. It is recommended that a similar questionnaire will be used in the future to study the local environmental attitudes and also the environmental motivators (see chapter 2.6.2 for the descriptions of “defensive” and “supportive” environmental identities). The motivation factors should be better understood to motivate both the MEEP savings and the environmental development work. A compulsory survey would force the participants to think about their own motivation factors. The MEEP savings operations will need well-motivated employees to be successful.

The factory steering committee should reflect on the following comments regarding the current state of environmental communication:

- *If we mention any existing problem to the local managers, all they say is, "what could you yourself do for this situation to get better?" We feel that this avoidance is the only response we are able to get. Then, at some point, we just get tired of getting the same response over and over again.*
  – An experienced production worker in October 2016
- *We attended the Green Office program in the past* (researcher's note: Metso Minerals was still an active member of the WWF program in 2016 and 2017). *We got those porcelain coffee mugs, and the disposable coffee mugs were taken away. But I guess the program is not really active anymore. No one has heard anything about it in a long time.*
  – Several members of the Operations Development Team in August 2016
- *The company seems to invest a lot of resources in development projects, not processes. After the projects end, there might be no one in the permanent employees' organization to take care of the development in the long run. The only employees who were officially responsible for HSE and quality related management systems are not working for the company anymore. No one has fully taken over their duties in the sense that there would be some kind of formal follow-up ensuring the continuous PDCA development.*
  – An engineer working for the production organization in February 2017

Based on the comments above, both the local HSE employees and the local Green Office employees should communicate more actively than in the past few years. The comments portray a lack of trust in the continuity of environmental development and the resources available.

The managers have clearly emphasized the importance of awareness and creative thinking in the everyday communication. Based on the response, more attention should be given to the exact way of empowering employees. Awareness training, possibly in the form of an everyday discussion, is a good basis that enables independent thinking. Still, encouraging the employee to think more creatively is not enough. The encouragement has to be complemented by truly sharing one's managerial power and resources with the actively employee. In practice, the best way is often to record the development need together with the employee. Neither the employee nor the contacted manager or specialist should have to work alone on the case.

Some employees currently feel that is it difficult to find or form *temporary* cross-functional teams to work on an issue together. This problem should be discussed on managerial level in all parts of the manufacturing organization.

Most of the briefly interviewed employees, some 30–40 in total, mentioned that the state of the factory seems better than ever before from the environmental point of view. The environmental perspective has been added to everyday work and communication. The possibility to recycle almost everything, including biodegradable waste, has been considered the most important and most visible change.

4.3.4 The basis for establishing a new EMS

Environmental management at Metso is based on Metso's Health, Safety and Environment Policy that is reviewed yearly by the Metso Executive Team. The policy is in line with the ISO 14001:2015 standard.

The Tampere factory has a certified ISO 9001 quality management system. It was estimated to be unsuitable to be combined with any ISO 14001 based environmental management system by the Operations Development Team. Even though ISO 9001 and ISO 14001 have been developed to work together, the quality management system available was old and documented in Lotus Notes that was planned to be decommissioned and achieved in the near future. Also, the position of the employee responsible for the quality management system had been discontinued.

An occupational safety management system had been created for the factory as a thesis project in 2011. However, there was no occupational safety management or environmental management system in use in 2016. Due to unexpected changes in the organization, it was unclear in 2016–2017 if the whole factory had ever had an HSE management system in active use.

The Lokomo foundry had had an environmental management system in the past and was supposed to have one also in 2016 and 2017. However, the documents were never received for an analysis in spite of several requests between September 2016 and February 2017. It seemed to be unclear to both parties what had happened to the environmental management system when the foundry business had been sold and the premises leased in April 2015. The other company, Tevo, does have its own corporate-level environmental management system, but its documents were not available for comparison during this thesis project. The quality manager of Tevo Lokomo started building a comprehensive environmental management system for Tevo Lokomo during spring 2017.

The past Materials Technology business line of Metso used the Quality Records model for all quality-related processes (see table 4). The environmental records were kept in the same way.

Table 4. *The way of keeping the quality records and the environmental records at Metso Materials Technology. The explanations marked with an asterisk symbol (*) are not mentioned in the original written material.*

Process	**Type of record**	**Responsible**	**Identifier**	**Control**	**Retrieval**	**Storage**	**Retention time**
Process name	*Topic**	*Person or function**	*How to recognize the detail in question**	*Way of managing**	*Tracking the development**	*Database and confidentiality classification**	*Normally 3 years*

The types of environmental records were:

- The environmental questionnaire to employees
- Legal and other requirements
- Nonconformities (environmental matters)
- Inquiries from the interest groups
- Environmental aspects
- Environmental objects and targets
- The supplier questionnaire
- Environmental programmes
- Environmental measurements

The original environmental records had been deleted before 2016. The current HSE employee had not seen them. Contacting the previous HSE employees was not possible. Analyzing the old records from the same premises would have been extremely useful for both the research project and the future development work.

4.4 Prioritizing the development tasks

Local environmental management should closely follow the guidelines of the HSE Roadmap for 2017–2020. The following subchapters describe *what kind of local environmental development projects have been initiated and would be needed next to follow the global HSE policy*.

The most important formal development task is ensuring the company's compliance with HSE legislation. The first task is listing the HSE legislation relevant to the production organization. The second task is assessing the compliance. The assessment should be performed once a year and always in a group meeting. The listing should be completely re-evaluated at least every 3 – 5 years, and checked every year before the yearly legislation follow-up meeting.

Future HSE benchmarking should focus on documentation and the benefits of careful documentation. This far, the benchmark visits have mostly focused on practical development issues concerning occupational safety. The future visits could be organized around the following questions:

- How to take care of the HSE documentation as efficiently as possible?
- How to motivate employees to attend an environmental training and to develop their own working methods?
- How to anticipate legislation changes and get the most benefit out of compulsory legislation follow-up work?

It is important to note that the Lean daily management system cannot substitute the need to create management documents. On the other hand, supportive HSE leadership is needed during the daily team and factory meetings, and documentation cannot substitute the leadership.

4.4.1 Local environmental management system recommendations

Based on ISO 14001, the environmental management system needs to recognize and give instructions regarding the following matters (SFS-ISO 14001:2015):

- **Clause number 4: Context of the organization**
  - Understanding the organization and its context
  - Understanding the needs and expectations of interested parties
  - Determining the scope of the environmental management system
  - Environmental management system
- **Clause number 5: Leadership**
  - Leadership and commitment
  - Environmental policy
  - Organizational roles, responsibilities and authorities
- **Clause number 6: Planning**
  - Actions to address risks and opportunities
  - Environmental objectives and planning to achieve them
- **Clause number 7: Support**
  - Resources
  - Competence
  - Awareness
  - Communication
  - Documented information
- **Clause 8: Operation**
  - Operational planning and control
  - Emergency preparedness and response

- **Clause 9: Performance evaluation**
  - Monitoring, measurement, analysis and evaluation
  - Internal audit
  - Management review
- **Clause 10: Improvement**
  - General (general improvement)
  - Nonconformity and corrective action(s)
  - Continual improvement

It is recommended to create this structure on the HSE worksite. Each clause should be a directory that contains at least one document that describes how the requirements of that clause are dealt with in Tampere. It is also possible to use the environmental record topics from Metso Materials Technology as titles when creating material on the new HSE worksite. The benefit that model offers is clearly listing the responsible person and the retention time (or the update interval).

Later on, at least the general structure of the management system should be published on the intranet as well. The contents can be published as documents or links only. The different parts of the environmental management system need to be easily available for all employees working in Tampere, and preferably also in other Metso locations. Only the confidential details, such as the budget, should be available upon request only.

4.4.2 The roles and the responsibilities

According to Metso's own internal rules, a site that has this many employees (more than 700) should have more than one full-time HSE employee. Now that the site does not have a local HSE manager but only a site manager and a global HSE manager, both with wide responsibilities in several locations, appointing a *formal* environmental manager would be beneficial. The current site manager had been the formal environmental manager before 2016, but in 2016, it was unclear whether the environmental manager was the site manager, the HSE specialist, or someone else.

A new HSE Manager should be recruited in the near future. If needed, the working hours of the manager can be divided between the local maintenance team and HSE or the quality function and HSE. The HR function should discuss the competency requirements with the global HSE employees. The competency requirements should then be listed for Tampere based on other locations' experiences. It is good to note that in Finland, it is common to require a Master's degree for managerial positions.

A new appointment would bring new attention to the local HSE work, even if a new full-time employee couldn't be hired. The role could be a part-time role, *in addition to other duties*. Usually the formal environmental manager is the HSE specialist if there is a local HSE specialist. However, also a maintenance manager, a site manager, a devel-

opment manager or any general manager can be the formal environmental manager if the HSE Specialist wants to focus on occupational safety, including, but not limited to, machine safety and safe work procedures. If a new employee could be hired, hiring an HSE Manager with formal management system responsibilities should be considered.

In Tampere, language skills have not been an issue in global HSE cooperation. Every employee with HSE-related responsibilities speaks English fluently. However, in another Nordic location, the HSE personnel not speaking English fluently has made global cooperation difficult. Language skills should be on the requirement list when hiring formal HSE employees, even if the position is local. This need is due to the fact that internal benchmarking is a very important part of HSE work in global corporations.

The Tampere organization would need a local HSE Forum or HSE Steering Group that would meet at least once a month. There are several local steering groups already, but because HSE is only one issue on their agenda, it is currently possible to replace environmental issues with occupational safety issues or energy issues. Substitution should not be possible.

The dream team for the local HSE forum would consist of:

- The vice president of Tampere manufacturing
- The HSE Manager (*in addition to other duties* if needed)
- The HSE Specialist
- One or two representatives from the maintenance team
- A lean specialist (any of the current lean development specialists who are specialists *in addition to other duties*)
- A quality specialist (to help combine the environmental message and the quality targets of LAPA and other internal quality-related development projects)
- One or two of the manufacturing managers (as chosen by the vice president of Tampere manufacturing)
- One or two of the production supervisors
- Only when needed: the local representative of L&T

The HSE forum should plan and budget the HSE work in the same manner as the operative and strategic steering groups plan and budget the maintenance operations and environmental services. There should be a clear agenda for each month. The meeting minutes should be made internally available to every employee interested in HSE issues. This would be the main difference: the other steering groups only share their notes to the relevant employees, not to anyone who might be interested in learning more. In this sense, the operating model should be similar to the meetings of the statutory health and safety delegates. The safety-related decisions made in their meetings and with them have been published so that all interested employees can follow the discussion. However, if an incident has been discussed, no names have been published.

The environmental services, such as recycling and cleaning, can still be dealt with in the operative and strategic steering group meetings, in the same way as before. The HSE forum should focus on a few safety topics and a few environmental topics each month. The HSE or HSE-related budget available should also be discussed, but the financial details don't need to be included in the meeting minutes. The MEEP energy savings and their real impact on HSE should be discussed in any or all of the steering group meetings.

The benefit of having a forum for HSE development only would emphasize the shared responsibility of planning and implementing changes. The HSE function is a development support function that offers expertise in the field of HSE. It does *not* take care of all development tasks independently. The role of HSE as an "implementing function" was found out to be a common misunderstanding. It is essential that all managers understand that they are still responsible for planning and implementing the changes that are needed within their field of work or in their workshop. The HSE function facilitates the PDCA development process and works on finding the development needs and opportunities.

At the moment, the approval process of new chemicals is managed by the HSE function and the local occupational health center. The workshops would need separate chemical coordinators (*in addition to other duties*) to clarify the purchasing and storage rules and to help the HSE. This far, the areas have not had coordinators for chemicals, which has led to some of the batch sizes being random or unknown. The logistics function has regularly had challenges with finding enough chemical catch basins for all barrels and other chemical containers, even though new chemical catch basins have been purchased only some time ago.

The problem with the chemical responsibilities is that currently no one can control the big picture. As long as too many different employees are allowed to purchase any amount they need themselves, the storage situation is difficult to control and running out of chemical catch basins will keep happening. As they are a requirement in the chemical legislation, it is important to actually manage and control the amount of chemicals stored. Even though Würth manages some of the purchase data, it doesn't own all of it, and it cannot manage the amount of chemical catch basins available.

Every year, the local HSE function collects a list of the current chemicals and the amount of each chemical. The list is sent to the Finnish authorities and saved for future reference. This system works well, but the amounts would be easier to find out if each workshop or area had a chemical coordinator. In the future, the InstaAudit chemical list should also automatically list the warning symbols and risk phrases of the chemicals currently stored somewhere in the location. The chemicals that are harmful to the environment should be discussed with the maintenance function in the same manner as the

chemicals that can be harmful to the human health are discussed with the local occupational health center health.

One of the strategic topics the HSE forum should discuss is outsourcing the HSE knowledge. At the moment, the cooperation partners, such as L&T and Würth, collect, analyze, and own a wide share of the Metso Minerals HSE data. Is outsourcing a sustainable model in environmental management? Is it strategically safe to outsource environmental planning?

4.5 Development projects

The practical development projects that were initiated during the thesis follow the global HSE policy and reinforce the weaknesses found in the current state analysis in Appendix B. More than 20 Sustanalyzer reports were written about environmental and safety risks to save the findings and make them publicly available for all users with an account (all employees with office responsibilities). The findings and development recommendations were read and checked out by the managers responsible for the area picked in the report view.

The "Environmental Protection Expenditures in 2015" form of Statistics Finland was also answered within this research project. In the future, the form should be filled out by the HSE and maintenance function in cooperation, or, if possible, by the local HSE forum or steering committee. It should be a part of the "check" activities of the PDCA cycle, not just a single task.

4.5.1 HSE Roadmap 2012–2020

Local HSE work for 2017–2020 was planned in November 2016 by creating a visual HSE Roadmap. The environmental part was planned within this project. The roadmap was reviewed and officially approved in December 2016. The HSE roadmap is an internal HSE development tool that describes the most important development steps and the cultural change in local HSE work between 2012 and 2020. The roadmap was written in Finnish and designed to be a visual timeline with titles and targets.

The local HSE specialist is responsible for updating the HSE roadmap. The vice president of manufacturing is responsible for reviewing and approving the roadmap. It commendable to review the HSE roadmap at least once year, around December.

The following guidelines were given and accepted for the roadmap as non-binding targets. Local HSEQ (health, safety, the environment, and quality – a combined management approach) management and leadership focus:

- 2016–2017: Current state analysis

- **Year 2017:**
    - Including environmental targets in all occupational health and safety target listings (such as the number of Sustanalyzer reports per employee per year)
        - Reporting all environmental incidents as soon as possible, but at least within 24 hours
    - Understanding the concept of environmental waste together with the HSE and the lean value stream mapping specialists
    - Understanding what the percentage of waste recycled consists of and where the dangerous waste that cannot be recycled is in the data (source: L&T data)
    - Implementing the Metso Office HSE Program (published internally by the Metso Corporation in 2016)
- **Year 2018:**
    - Active HSE forum or steering committee
    - Environmental targets and responsibilities always included when listing health and safety targets and responsibilities
    - Separate environmental targets for the internal manufacturing areas
    - The scrap percentage is actively followed and understood as a way of feedback
- **Year 2019:**
    - "Lean HSEQ Forum": the HSE forum actively cooperates with the lean specialists and quality specialists
    - Proper PDCA approach in environmental work, the HSE forum taking care of the follow-up
    - The HSEQ management system documented as one entity
- **Year 2020:**
    - H, S, E, Q, and lean are taken into account in every decision: in projects, in the daily manufacturing operations, in all steering committee meetings, and in every other relevant activity

The environmental targets for the upcoming years:

- Before 2016:
    - Recycling bins for kitchen waste to all lunch kitchen areas in the manufacturing buildings and to all office spaces
- **Year 2016:**
    - More than 85 % of the waste recycled (the target was reached)
    - The first 15-minute recycling info sessions for manufacturing employees, organized by L&T
- **Year 2017:**

    - The Sustanalyzer reporting target of “at least three safety observation reports” per employee per year is now “at least two safety observation reports and at least one environmental observation report” per employee per year
        - The reporting rates are actively followed
    - Following the recycling rate separately in each area and publishing the results on the digital information screens
    - A 15-minute recycling info session for each area, organized by L&T (started in 2016)
    - New possibilities to recycle cardboard even more efficiently than before, coordinated by L&T
- **Year 2018:**
    - Every employee reports at least one environmental risk, one type of environmental waste, or one general environmental observation in Sustanalyzer (and 2–3 safety observations)
        - The teams that haven’t reported actively enough are contacted
        - The most active employees and teams are rewarded
    - Every employee knows how to recycle all the different types of waste in the most efficient way, including the plastic parts, the wooden items, and the cardboard
- **Year 2019:**
    - ”No waste, only recycled raw material”: firstly, everything that can be reused is reused, secondly, everything that can be recycled is recycled – only hazardous waste is treated professionally
    - Environmental waste is included value stream mapping, the lean management method that was first implemented in this location in 2016
    - No unnecessary scrapping: the scrap percentage is actively followed and connected to the management feedback systems (possibly even to the reward systems)
- **Year 2020:**
    - The MEEP targets have been reached:
        - Energy consumption -20 % (compared to 2009)
        - CO_2 emissions -20 % (compared to 2009)
        - Water consumption -15 % (compared to 2009)
    - Scrap and waste controlled

The ultimate goal of HSE work is to create a shared habit of discussing HSE issues in every meeting and encouraging one’s coworkers to report and actively work on HSE risk observations and HSE-related development. The target of discussing HSE in the beginning of every meeting was reached in many teams and meetings in the production organization in 2016–2017.

The development of HSE work itself is heading towards using flexible cloud services. The new InstaAudit system has made the tablet an important tool in HSE work. The plans for 2017–2018 also include printing chemical safety instructions for each chemical directly from InstaAudit in size A4 and printing new chemical container and canister labels with the appropriate warnings. Material safety data sheets will be up-to-date online, and they can also be printed out from the system if needed. The new chemical register module offers a view that shows, for example, all locally stored chemicals that are potentially harmful to the environment. In the future, the chemical register should also show their current amounts and storage locations. This functionality will help keep the environmental risk analysis up to date.

4.5.2 Environmental aspects and impacts

Metso's general environmental aspects and impacts assessment form first builds the background for the importance of working on environmental issues. It lists the most harmful environmental issues of the present time. Climate change, pollution, environmental degradation, and resource depletion are mentioned in the example form to create an image of why managing environmental impacts is important. The example form does not make a big difference between local and global issues, but it is versatile. The user is responsible for prioritizing.

The most important environmental aspects were found to be:

- Electricity and district heating consumption
- Water consumption (drinking water quality only; lake water consumption not remarkable compared to the large size of the local lakes)
- The chemicals used and stored in the area, both inside and outside
- Packaging materials
- Business travel

The most important environmental impacts were found to be:

- Climate change
- Light pollution at night
- Chemical (such as oil) residues in the soil and in the wastewater
- VOC emissions (volatile organic compounds) from several sources but especially from the painting process
- Waste transportation

It is recommended to analyze the procurement operations and the external logistics separately. That is because the decisions concerning the impacts of those operations are made separately, in the corresponding functions.

4.5.3 Environmental risks

According to the environmental law, the operator has to know the environmental risks of the operations. This requirement is best fulfilled by creating, saving, and periodically updating a formal risk assessment document. The risk assessment doesn't need to be sent to any public authority as long as an environmental permit is not needed.

The local environmental risks should be formally assessed as soon as possible. The assessment document was prepared in early 2017, but it was not officially finished due to scheduling challenges. Risk assessment work is always group work. It is also recommended that at least one of the managers with legal responsibilities or the right to represent the company legally supervises the assessment.

In the draft phase, the most important (both likely and potentially serious) environmental risk identified was an oil spill from a test run engine. The test runs are performed in two separate test run areas that are not covered with asphalt or concrete. An oil spill is also possible from any chemical container or oil barrel stored outside very close to the highly trafficked truck and forklift routes. However, the oil collection tanks should safely stop the sewage leakages. The number of chemical catch basins available should be balanced with the amount of chemicals purchased (see chapter 4.4.2). The most serious but not likely environmental risk was estimated to be a fire (harmful gases) together with a large wastewater spill (chemical residues). A large wastewater leakage would not necessarily stay inside the factory area with the current fences.

The final risk assessment can be conducted using InstaAudit. The risk assessment group should be similar to the proposed HSE forum or steering group. The document can be written in Finnish to make it easy to read for the local employees. The global HSE employees only need to know that the risks have been assessed and that the document is truly up to date.

According to several interviews with the local maintenance personnel around September 2016, the plot of land has been in industrial use for more than 100 years and the environment hasn't always been understood as a "shareholder" in the past. The ELY Centre of Pirkanmaa instructed in 2016 that if the way of using the whole industrial area goes through a major change in the future, then the condition of the soil should be analyzed. As long as the area continues to be in industrial use, there is no need to analyze the whole area. Minor analyses have been conducted already.

4.5.4 Emergency and rescue plan

The *Lokomonkatu 3* emergency and rescue plan was updated during summer 2016 and published internally in September 2016. The parts concerning only the foundry were updated in cooperation with Tevo Lokomo. The final version was shared with and ac-

cepted by the local Metso Minerals managers and Tevo Lokomo. The following tasks were performed to support the document update:

- Locating the wells, including the oil collection tanks
- Locating the correct closing valves of the gas tanks and gas lines
- Ordering new layout drawings (related to safety management)
- Official fire inspection (including document preparation)
- Cleaning the underground shelters

Some practical instructions were added in the emergency and rescue plan. The routes to the closing valves and the valves themselves were photographed. The photos were combined with written instructions on how to close the valves in the case of an emergency. Purchasing carbon dioxide extinguishers was considered. They would be beneficial especially in the rare case of an electrical fire where the electricity cannot be turned off for some reason.

Local training needs were listed. Emergency trainings were organized for all emergency contacts. Each training lasted several hours and included walking the relevant safe escape paths (exit routes). Preparing the emergency contacts list for maintenance and environmental emergency situations was also a part of updating the emergency and rescue plan (see chapter 4.3.3).

The local emergency services are legally responsible for creating and updating a fire water plan that covers at least the extinguishing water. However, the business operator is responsible for creating a wastewater plan for the case of a fire. This plan is a part of the emergency and rescue plan. The wastewater plan of the Tampere factory was updated in 2016. It needs a further update in 2017–2018 because it possibly lacks some details.

4.5.5 Recycling

In 2017, the areas reserved for recycling purposes were reserved and marked more carefully than before. New, easy possibilities were organized for example cardboard and wood recycling because L&T returns some money for correctly recycled, baled cardboard and broken but fixable wooden pallets. The responsibility of emptying the cardboard balers was transferred from Metso, the customer, to L&T, the machine owner, for safety reasons. The balers are machines, and the occupational safety and health legislation requires that each employee using a machine at the workplace has got a formal training. The exact methods that return some money were also emphasized in the communication. Very few employees had known that it is possible to earn some money back from L&T with proper recycling.

In 2016, 84–89 % of the waste produced locally each month underwent a recovery operation, that is, was reused or recycled. Almost every month, the local recycling target was reached or exceeded. The most common rate was 89 %. The target is "> 85 % reused or recycled", and the rate is followed monthly. The amount of waste is currently calculated by L&T in such a way that reaching 100 % would be virtually impossible. The share of "15 % of waste not reused or recycled" represents the hazardous waste that can only be professionally treated and professionally incinerated. It would be beneficial to better explain the nature of this share of waste in the internal communication.

The messy pile of pallets in the middle of the factory area was considered to be the most visible recycling problem. The wooden pallets are supposed to be either reused or recycled. The ones that are not broken should be collected in straight piles so that they can be easily reused. The ones that are broken should be collected in separate piles. L&T will collect, fix, and resell them and return some of the money. Only the ones that are in small pieces, that is, unfixable, should be considered waste wood. The problem of messy piles appearing around the recycling area had existed for several years before 2017. The logistics employees told that the areas reserved for recycling purposes had been simply too small and unmarked. Acting in the wrong way had been too easy, and acting in the correct way had been slow. The issue had been called an attitude issue, which frustrated some of the employees who told that they would like to act in the correct way if only it was easy enough. The real problems behind the visible issue were discussed in several meetings, and better organization of the recycling areas together with HSE discussions with the logistics professionals helped successfully solve the problem.

4.5.6 Green Office updates

Originally, the WWF Green Office program was not in use in the offices of the production organization. The offices of the main building had reached the savings targets after one active year (2015). The Green Office Compass site and the other local material had last been formally updated around 2015. However, the annual green campaigns had been active each year. Since the factory and the offices are located only some 1,0–1,5 kilometers from Tampere city center, encouraging cycling had always been important in planning the summer campaigns. Cycling had been encouraged, for example, with a lottery and by giving a free breakfast to everyone who tries cycling to work within a certain time period in the summer.

Within this project, the Green Office meetings were visited to find out how much the program has cooperated with the local HSE. Cooperation projects were not found. A new environmental program (annual plan) was created for 2016 and 2017. The green summer campaigns were included in both plans. The rest of the planned activities were related to maintenance and the office spaces of the main building. The Green Office intranet pages, including the recycling instructions, were also updated.

The WWF Green Office activities should create excitement and give new ideas, not be a burden. The summer campaigns have been a great way to inspire. However, the sense of community in the development work has been somehow lost. The team could ask some managers with relevant responsibilities or interests to attend at least one meeting to gather new ideas based on the real development needs in the manufacturing organization. Many of the discussion topics, such as motivating recycling, are issues that are shared with the production organization anyway. The local HSE should also be a part of the WWF Green Office group and strengthen the role of the program in the production offices. There is no reason (financial or any other) to leave the production offices out.

4.5.7 Environmental training

A pilot on environmental training for employees had been carried out before 2016. Participating this 8-hour course to get the Finnish Environmental Safety Card was voluntary. Course hours were normal, paid working-hours and they had to be negotiated with managers beforehand. No data about the participants was available for this thesis. General feedback had been positive, but the course did not cover local issues, such as the locations of oil spill response equipment.

First Tampere-themed Environmental Safety Card training for employees working in the production organization was booked for February 2017. The plan was to train more than 20 blue-collar employees and managers to be able to respond properly in abnormal situations and to share knowledge about the importance of recycling and choosing the right chemical for the task at hand. The course was ordered for a licensed safety card training company that knows the working environment at this particular factory.

Advertising the February 2017 environmental training was plain and direct. The training opportunity was advertised on the digital information screens and on the intranet by mentioning the name and the date of the 8-hour training. Some managers were also directly contacted and asked to name employees to whom the training might be particularly beneficial. The unofficial target was to train 20 % of the factory personnel in the first phase.

In the next environmental training phases, it would be beneficial to calculate how many employees have to be trained in order to 10 % of the population to hold the opinion in favor of the environmental savings and development needs. The minority opinion only starts spreading fast when 10 % of the population actively supports it (see Xie et al. 2011). It is likely that much more than 20 % will have to be trained before the environmental attitude starts spreading. From the informational point of view, it would be beneficial to train 100 % of the employees.

Within this thesis project, several environmental management presentations were given to local managers in January and February 2017. The presentations lasted 30–60

minutes each, and the informal discussion lasted 15–30 minutes. The following groups were asked to participate:

- The factory steering committee
- Manufacturing managers
- Foremen (production supervisors)
- Development engineers

The main goal of the presentations was to raise awareness and train the managers in a fast and interactive way. The second goal was to discuss the current issues, especially the messy pile of pallets in the middle of the factory area, and to find new ideas for motivating everyday recycling. The target "> 85 % of waste reused or recycled" was discussed because the meaning of the 15-percent share was unclear. It is advisable to properly explain the meaning of the 85-percent target in the internal HSE target communication (see chapters 4.5.1 and 4.5.5) in the future.

It might be beneficial to occasionally hire professional trainers who are fluent in public speaking and excited about teaching. It is important to make studying the environmental topics and looking for environmental solutions exciting and satisfying. The HSE or the HR function should give more attention to the way the internal HSE trainings are advertised. The advertisements should always answer one question: "How will I be able to work better after attending this training?"

The local production organization should make the MEEP targets more visible and understandable. The current level of savings development could be discussed more often in the local factory or production meetings and in all steering group meetings. The savings level could also be made more visible by showing at least the annual development on the info screens in the production. Even though minor improvements or savings in operational work might not be easily seen in the graphs, being reminded about the targets would add some pressure. The maintenance and HSE employees should then communicate what each employee group can do to help reach the targets. The good changes in energy consumption habits should also be made a part of the lean rewarding program led by the lean specialists.

There is clearly a need for HSE legislation trainings in the organization. Gaining legal knowledge is currently considered difficult. All managers and other professionals whose work is in any way related to HSE issues should be able to receive some kind of legislation training. One live training, a material package, and an online link listing should be offered to different employee groups every year. The legislation training should be compulsory to every employee making HSE-related decisions and freely available to everyone interested in understanding legal HSE requirements. During this project, a basic-level information package was prepared on HSE legislation related to common

HSE topics such as chemicals and waste. That material can be used a basis for a more comprehensive training package.

4.5.8 Other update needs

The chemical handling instructions for Finnish employees were updated and uploaded on Avenue. A draft of a local environmental guidebook was created. The goal is to collect material for a comprehensive local handbook that covers all environmental matters that an employee working in Tampere should know about.

New oil spill equipment was purchased to certain outside areas. The emergency equipment boxes were equipped with laminated emergency instructions. The inside areas already had enough emergency equipment.

Major changes were planned regarding the current environmental insurance. The details are confidential. A state authority confirmed that an environmental insurance is not mandatory for the machine-manufacturing part of the factory at the moment. It is mandatory for the foundry operations only.

5. DISCUSSION

This thesis project was the first environmental management themed project at Metso Minerals in Tampere. A big part of the project was defining what local environmental management is in the first place, and what it should be. Environmental management is a large field that can never be looked at as a task, or a list of tasks. It should be a part of all management. It should have an effect on every decision made. As seen in this thesis, it also requires continuous cooperation between different teams, just like occupational safety.

5.1 Scientific and practical implications

This research project contributed to a detailed understanding of how to improve environmental management without creating an environmental management system for certification purposes. While research projects concerning the creation and implementation of a company-wide, ISO 14001 certified environmental management system are rather common in the field of environmental management, there is perhaps less information available about how to realistically improve local management when building and documenting a company-wide management system is not possible.

The interview findings explain how even well-intentioned comments from middle management can deteriorate the motivation to actively improve the working methods if the employees feel that appropriate help is not readily available. Empowering employees is not only about using empowering words, but also about using one's existing power in the organization to make doing something possible and worthwhile for the other employee. The development projects that were initiated during the research demonstrate how to combine energy management as a natural part of HSE work, not just maintenance work.

The results offer a workable environmental management solution for the company. It is possible to complement this project by creating a formal environmental management system, but the results and recommendations can also be followed without creating a formal management system. These practical recommendations can be followed despite any future changes in the HSE targets or the HSE roadmap, at least as long as the environmental policy of Metso follows the requirements of ISO 14001:2015.

This report presents ideas and recommendations based on the assumption that following the standard SFS-EN ISO 14001:2015 offers a satisfactory level for environmental management and environmental thinking in the organization. The standard, however,

does not make a difference between legally adequate actions and operational excellence. Following the standard does not automatically ensure legal obedience. Following it only forms a solid and credible basis for legal obedience. The standard strongly emphasizes the importance of legislation follow-up and careful documentation. A separate research project could carry out a gap analysis between an ordinary EMS fulfilling the requirements of ISO 14001:2015 and the Finnish environmental legislation.

The order of the practical development projects during this research project was more coincidental than strategically planned. The budget for the year had already been decided before the initiation of the thesis project, so the leeway for new projects and schedules was limited. However, the whole development and HSE budget was confidential and not available for an analysis, so the development tasks could not be prioritized properly. Only the budget for mandatory environmental maintenance operations, such as recycling and cleaning, was available.

Major changes had taken place in the organization around 2015–2016. The lack of experience in the new organization occasionally caused intermingling of environmental and energy issues, which led to some of the development tasks being more related to energy saving standards than ISO 14001.

The limited time available caused the focus to be on research work and initiating development steps and projects. In a longer research project, the focus should be more on balancing the PDCA development cycle and planning the mandatory annual activities. The development projects described in chapter 4.5 do not necessarily picture the most efficient way of influencing the emissions or environmental impacts in of a machine manufacturing factory. They were the projects that were needed based on the ISO 14001 analysis findings and possible to start within the development budget that had already been decided before this research project.

5.2 The qualitative rigor of the thesis

Lincoln and Guba (1985) proposed a model of trustworthiness of qualitative research in their classic work on naturalistic inquiry. The model addresses four components of trustworthiness that are relevant to qualitative research: (a) truth value (credibility), (b) applicability (transferability), (c) consistency (dependability), and (d) neutrality (confirmability). (See Lincoln & Guba 1985 and Thomas & Magilvy 2011.)

A qualitative study is considered credible when it presents an accurate description or interpretation of a phenomenon that those people who share the same experience would immediately recognize. Examples of strategies used to establish research credibility include reflexivity, member checking, and peer debriefing or peer examination. The ability and effort of the researcher also has a major impact on the credibility of any research study. Reflexivity, similar to construct validity in quantitative research, requires

a critical attitude on how any preconceptions might affect the research. (Thomas & Magilvy 2011.) The reflexivity influencers are discussed in chapter 5.1. Since the research was conducted right after environmental management university studies with a very short working history in same part of the manufacturing organization, there should be no major issues regarding the ability to address the correct and common issues in an unbiased manner. However, member checking, second interviews where every participant would analyze the research results and fill in any missing pieces, could not be organized due to scheduling and resource challenges.

The ability to transfer research findings or methods from one group to another is called transferability in qualitative language, equivalent to external validity in qualitative research (Lincoln & Guba 1985, p. 290). A common method to establish scientific transferability is to provide a dense description of the population studied by providing descriptions of demographics and geographic boundaries of the study. Sometimes, repeating the same study methods with different researchers or research assistants, or a different group of interviewees in a different geographic location, might yield different results. (Thomas & Magilvy 2011.)

In a study of this kind, the transferability is good regarding the recommendations given. The deficiencies found are not directly applicable knowledge in another organization. They could potentially be very different, even after a similar "0–5 points per subclause" analysis. Finding the most successful implementation methods may be somewhat dependent on the local culture or the company culture, but the need to consistently solve the issues found is not dependent on the culture of the local HSE targets. ISO 14001 is a global standard, and there are no well-known standards in the market that would substantially disagree with its contents. As discussed in chapter 5.1, repeating the same study could produce a different order for the development projects. Still, the 0–5 points analysis method and the development ideas are directly applicable in any similar setting.

The results can be considered consistent and dependable when another researcher can follow the decision trail. The best way to produce dependable results is to offer a detailed description of the research methods used. The description should include the specific purpose of the study, a description of how the participants were selected for the study, and how the research data was collected and reduced or transformed for the analysis. The interpretation and presentation of the research findings should also be discussed. If possible, also the specific techniques used to determine the credibility of the data should be explained. (Thomas & Magilvy 2011.)

This report offers a description of the research methods used and information sources available in the setting. Some of the data and issues analyzed during the project were business confidential, which might make following the logicality of the exact decision path challenging. The research decisions were still made according to the requirements

of ISO 14001 and the implementation ideas given in ISO 14004, which should offer a sufficient level of consistency and dependability.

Confirmability, similar to objectivity in quantitative terms, occurs when credibility, transferability, and dependability have been established. It also requires to results to be neutral, which means that the researcher has to have worked in a neutral way, rather as a listener than an opinion leader. (See Lincoln & Guba 1985 and Thomas & Magilvy 2011.) The confirmability of this study can be considered good enough based on the reasons mentioned in the previous paragraphs. The project did not have a political or business-related agenda. The results were collected in a neutral way without the need to establish a certain model for commercial purposes.

The most significant shortcoming regarding the repeatability of this research project is that some employees whose work was actually related to HSE matters were not interviewed early enough during the research project. The difficulty of finding and meeting with the correct interviewees who actually knew enough about environmental management had an influence on the planning, the order, and the magnitude of the development tasks. The possible omission of any important environmental management or HSE related views, decisions, or documents is unintentional and does not designate their value to the local community.

When reproducing a study of this kind, it is important to distinguish between having the focus on environmental *management* practices and having the focus on *reducing* the most significant environmental impacts (see for example chapter 2.4.3). It is necessary to first research the management practices before the most significant issues can be tackled because the management practices strongly affect the future development in any case. The part of this study that can be directly reproduced at any Metso location is the current state analysis. The development projects can also be directly copied because Metso has the same environmental policy everywhere, but it is more efficient to plan the first development projects based on the findings of the local analysis.

The current state analysis results are generalizable. Still, the local legislation should be considered when prioritizing the development projects. The deficiencies that can potentially risk the legal compliance of the business activities in any way have to be dealt with first. In the analysis results, the local culture is not a significant factor. The results would be se same in another culture. However, in the communication and training recommendations the local working culture can play a small role. They should be adjusted to the local culture and working habits. The recommendations will be the same even if something in the HSE targets or the HSE roadmap changes by 2020. They are not dependent on the exact targets because the environmental policy of Metso is consistent with the requirements of ISO 14001:2015.

5.3 Ideas for further research

A further study could be conducted on the best available technology and lowest possible consumption and emission level for each financially significant manufacturing and maintenance process. Those results could then be compared to the current state of the processes and the environmental reporting of the site. The study should calculate and recommend the best development steps. Also, the level of the VOC emissions from the painting process should be analyzed again at some point. The painting process and the paint shops had been significantly improved before 2016.

The biggest challenge with the implementation will be continuity. The changes cannot be implemented by summer trainees, thesis workers, or other temporary employees. The managers and specialists will have to keep studying the topics and sharing the resources in such a way that the planned changes are possible without the daily work becoming unnecessarily slow. Ensuring the maintenance resources, both the investment funds and the employee resources, is now critical. Actively reading and using the ISO standards, such as ISO 14001 (environmental management) and ISO 50001 (energy management), is also strongly recommended. The savings within the MEEP program and the reached recycling targets have already shown that the factory is highly capable of managing the environmental issues of modern society.

6. CONCLUSIONS

The purpose of this thesis was to analyze the current state of environmental management at Metso Minerals Tampere factory according to the requirements of ISO 14001:2015 and figure out the next steps needed. The HSE organization had significantly changed in the past few years, and new knowledge and ideas were needed.

The information sources were company documents, databases, and local employee interviews. The target was to create a workable environmental management system and initiate useful development projects without creating a formal system for certification purposes. The comparison was performed from September 2016 to February 2017.

The current state of the environmental management practices got 74 points out of a theoretical maximum of 110 points. The numerical result can be used to track the development internally. The points do not portray the probability to get a third-party certification; a management system certificate could be received after simply documenting the current management system in a more detailed way.

The *actions to address risks and opportunities* and the *documented information* were found to be deficiencies that are a potential risk to the legal compliance of the organization. The lack of documented HSE legislation follow-up work and documented environmental risk assessment work was alarming. Minor deficiencies were also detected related to the documented identification of environmental aspects and impacts, managing the amount of stored chemicals, *environmental awareness*, and formal environmental *competence*.

The *understanding of the organization and its context*, the *corporate environmental policy*, *operational planning and control*, and the level of *continual improvement* in general were found to be excellent. The PDCA model is already a natural part of the local occupational safety work. Bringing it into the environmental work should be simple. The current state was estimated to represent the maturity level of *standardized* HSE work. The organization should next aim at the *automated* level where integrated databases allow forecasting and therefore accurate resource allocation.

The HSE Roadmap for 2017–2020 now includes separate environmental targets. The recycling target of “at least 85 % of all waste recycled” was reached already in 2016 almost every month. The dangerous waste cannot be recycled, but other ways of optimizing the recycling process were found. Improving the recycling areas of pallets, broken pallets (wood), and cardboard was initiated within this project. The target of report-

ing at least three HSE incidents, risks, or ideas per year was shared between environmental (minimum one report) and occupational safety issues (minimum two reports).

The Metso Energy Efficiency Program had been successful in Tampere. By late 2016, the 2009–2020 savings targets concerning local energy consumption, CO_2 emissions, and water consumption were approximately 50 % reached. Based on the former level of communication between the maintenance and HSE, it would be advisable to form a separate HSE forum or steering committee that would meet at least once a month. The current steering committees only have HSE as a whole on their agenda, which means that it is currently possible to omit the environmental viewpoints and only focus on occupational safety. The Green Office group should also actively cooperate with the local HSE support function.

The informal interviews showed that even well-intentioned comments from the middle management can have a deteriorating effect on the motivation to actively work on HSE issues if the employees feel that practical support is not readily available. The idea of empowering employees is about sharing one's power and the resources in the organization to make making a change possible for the other employee. Awareness training has to be complemented by cooperating with the active employee. All managers should also ensure that forming temporary cross-functional teams to work on a specific issue is encouraged and possible, taking into account the resource allocation methods and rewarding systems in use. The environmental trainings should be advertised based on the practical skills they offer, not only based on the topics, to attract more participants. Every employee should receive some kind of environmental training during the upcoming years. The HR and the HSE functions should follow the training rate more closely in the future.

The Operations Development Team and the local factory steering committee should now actively continue implementing the changes described in this report, together with the correct managers from the manufacturing organization. The *check and act* part of the PDCA cycle needs to be brought up as a topic of discussion in the relevant steering committee meetings. As seen with the development projects that could be initiated within this research project, it is possible to actively work on the environmental performance of the plant without having a formal, certified environmental management system. In the future, the creating a common, formally documented HSEQ and lean management system should still be considered.

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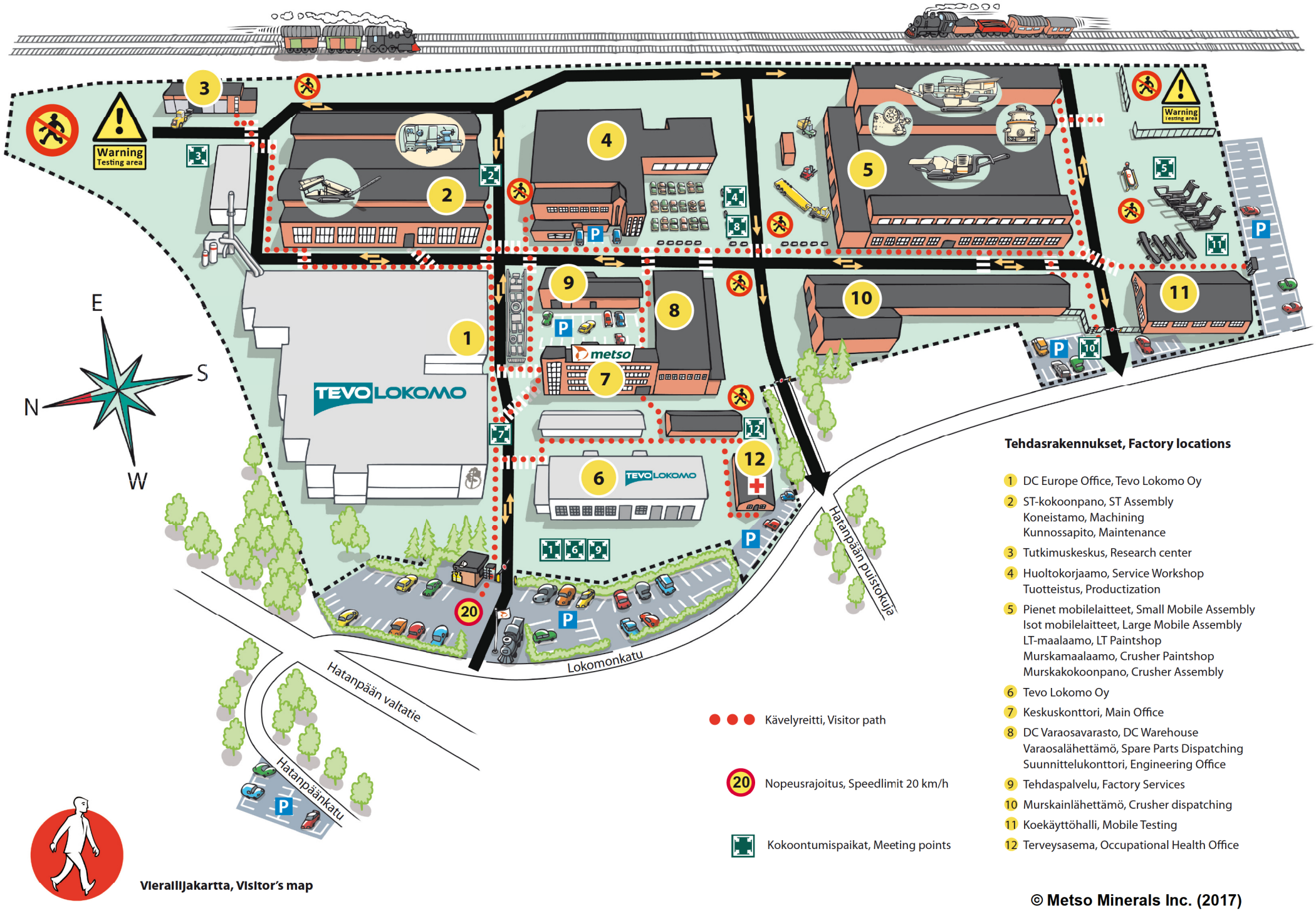

Vierailijakartta, Visitor's map

APPENDIX B: CURRENT STATE ANALYSIS

Table B-1. *The current state of environmental management in Tampere manufacturing according to the requirements of SFS-EN ISO 14001:2015. See SFS-EN ISO 14001:2015 for further details. These evaluations only consider the state of local environmental management in Tampere from September 2016 to February 2017 when the local organization did not have a comprehensive environmental management system. This analysis is not an EMS gap analysis for an official EMS certification. Please note that the explanation of what is expected within each clause of ISO 14001 is not included in the descriptions due to possible copyright issues.*

The requirements	**Current state, description**	**Current state, points given***
Clause number 4: Context of the organization		
4.1 Understanding the organization and its context	Excellent understanding of local operating and environmental conditions, the organization, and its processes and capabilities. Several documents are available on the Intranet.	5/5
4.2 Understanding the needs and expectations of interested parties	Very good understanding of stakeholders and their expectations. However, future expectations could be known better locally. Several documents are available on the Intranet.	4/5
4.3 Determining the scope of the environmental management system	The Green Office certificates on the walls of the local main office building claim that the organization has an environmental management system. However, the scope of this EMS is not	1/5 (not satisfactory)

	clearly defined, nor is it available to interested parties.	
4.4 Environmental management system	WWF Green Office can be considered an EMS regarding local office work. No EMS could be found in use in the production organization. Global HSE processes seem to cover a wide range of local environmental responsibilities, but local legislation follow-up is not in their scope.	2/5
Clause number 5: Leadership		
5.1 Leadership and commitment	Continual improvement is strongly supported by top management. However, to ensure effective environmental management also locally, top management should support the essential key persons in the same way they support them in developing occupational safety and wellbeing. Commitment should also be shown by allowing more maintenance resources to be used in systematical planning.	4/5
5.2 Environmental policy	Metso has a detailed global environmental policy that is updated and communicated internally every year. The policy is public. The global environmental policy does not set the requirement that every location should establish an	5/5

	EMS.	
5.3 Organizational roles, responsibilities and authorities	The environmental roles and responsibilities are clear regarding the tasks set by the Finnish authorities. However, internally, the roles and responsibilities between the local maintenance team and local HSE are vague. Top management has not shared the areas of environmental development responsibilities. Only the daily maintenance responsibilities and most reporting responsibilities have been clearly designated. Some energy and investment related reporting tasks and responsibilities have been habitually forwarded from HSE to maintenance and from maintenance to HSE again due to obscurity in the job requirements.	4/5
Clause number 6: Planning		
6.1 Actions to address risks and opportunities	The general knowledge level is good. In practice, undesired environmental effects are actively prevented and the risks seem to be known. Plans exist for abnormal external environmental conditions. Environmental aspects and impacts, environmental risks and opportunities, and legal compliance have	2/5 (not satisfactory)

	not been systematically assessed.	
6.2 Environmental objectives and planning to achieve them	Ambitious environmental objectives have been set exemplarily. Environmental indicators have been selected to evaluate the achievement of measurable environmental objectives. Proper planning has been done. The plans should have been communicated better internally. Even the factory steering group was not aware of some of the plans or the possible means of achieving the targets. Also, the managers who are not a part of the steering group should have got more information.	4/5
Clause number 7: Support		
7.1 Resources	*Human resources:* One local HSE person (one local HSE Specialist; no local HSE Managers) for a site that permanently employs over 700 people is not enough. Other Metso plants of the same size employ one HSE Manager and at least one HSE Specialist, possibly even more. Metso's internal rules state that both a manager and a specialist are needed when the number of employees is this high. The number of maintenance employees also seems too small compared to the number of daily	3/5

	maintenance tasks. *Financial resources:* The financial resources have always been sufficient for basic environmental services (such as recycling and professional cleaning services) and minor development projects (such as purchasing new equipment to make recycling easier). However, the financial resources have been somewhat insufficient for taking care of the old buildings well enough for several years already. In the past (for example 10 years ago), the budget was considered sufficient. Nowadays, the local maintenance team must choose between different repair projects each year. Unexpected maintenance expenses affect environmental development projects and investments. The amount and quality of natural resources and the infrastructure in the area are good from the environmental point of view. There is no extra storage space or unused land in the area, which encourages good housekeeping. The manufacturing technology and IT software in use are adequate and up-to-date.	
7.2 Competence	The organization has ensured the competence of the persons doing work that affects its environmental	2/5 (not satisfactory)

	performance and its ability to fulfill its compliance obligations. The organization has not determined training needs associated with its environmental aspects and environmental management system.	
7.3 Awareness	Middle management feels that the general awareness is not good enough. The implications of not fulfilling compliance obligations are understood well enough, but what contributes to the environmental performance and effectiveness of the organization is not well known. The lack of awareness hinders true commitment to environmental objectives.	2/5 (not satisfactory)
7.4 Communication	External communication has been very good. Internal communication has been partly good, partly lacking. Environmental legislation changes, for example, have not been communicated widely enough. Not all managers know what has been done and what will be done in order to reach the MEEP targets. The ways of internal environmental communication have not been systematically planned, but WWF Green Office tools have been utilized.	3/5

7.5 Documented information	Environmental performance has been systematically documented. Safety audits have been systematically documented, and they include some environmental safety findings. Environmental investments and development projects have been documented, but the data is not easily available for managers. Fire inspections have been documented. HSE legislation follow-up work has not been documented at all after 2011, or the documents have been deleted. This is a severe deficiency. Local environmental aspects and impacts are well known, but they have not been documented. The amount and the locations of stored chemicals have been documented, and the documents are updated regularly. Chemical handling risks and responsibilities have been carefully documented with Metso's own occupational health care professionals. However, chemical purchasing permissions and responsibilities have not been documented. An environmental training and training need database was in the plans for 2017. In 2016, all HSE-related training hours were already tracked. The target was 8 training hours per person per year. The amount of environmental training was not	2/5 (not satisfactory)

	separately tracked. It was still not possible to track how many employees had participated *environmental* training sessions. The emergency and rescue plan was updated in 2016. New emergency response team roles and responsibilities and the training needs were also documented. Energy-related issues, energy savings, and all maintenance projects have been documented consistently. A noise map and an odor analysis are available. Maintenance and energy related investment plans have all been documented carefully, and cost estimates are available.	
Clause 8: Operation		
8.1 Operational planning and control	In the *manufacturing* processes, the following requirements have been taken care of exemplarily: a) designing the processes in such a way as to prevent error and ensure consistent results; b) using technology (engineering controls) to control the processes and prevent adverse results; c) using competent personnel to ensure the desired results;	5/5

	d) monitoring or measuring the processes to check the results; e) determining the use and amount of documented information necessary to support the operation of processes. For the challenges in documenting environmental management, see subclause 7.5. In general, competent operational planning and control in the manufacturing ensures a solid basis for effective environmental management. However, there are mostly only safety and cleanliness related requirements and rules for the *partners* and *suppliers* operating on the same premises. (Researcher's note: Subcontracting is not included in the scope of this thesis.) For example, littering is forbidden in the local rules for partners and suppliers, but the rules don't mention the harmfulness of excessive use of plastic packing materials in general. The rules do state that all waste must be recycled at the end of the working day, but they don't mention the need to fundamentally prefer recyclable materials.	
8.2 Emergency preparedness and response	In general, the level of emergency preparedness has been good. In the official fire inspection in 2016,	4/5

	only minor deficiencies related to hot work and flammable material positioning were found. No acute hazards were identified. However, communicating the emergency plans and responsibilities efficiently enough has been a challenge. The emergency and rescue plan was updated and related trainings were organized in 2016. Preparing for oil spills was also further developed. The underground shelters were cleaned and evaluated, and a renovation plan was ordered from a consultancy. Emergency communication, including exact messages, was planned. A list of environmental, maintenance, and emergency contacts was given to every office and every part of the production halls. The preparedness for oil spills is still somewhat lacking because test runs are operated on two areas with no asphalt or concrete pavement. The local environmental authorities did not see this as a problem because the area is a very old industrial area with no major changes approaching. The area does not have a fence or embankment that would keep fire extinguishing wastewater inside the factory area. The fire extinguishing wastewater plan	

	is lacking. However, there are oil separators in all major wells, and the wells are cleaned annually.	
Clause 9: Performance evaluation		
9.1 Monitoring, measurement, analysis and evaluation	Environmental performance has been systematically monitored and analyzed. Environmental impact measurement projects have been carried out. This clause also includes the evaluation of compliance (see 7.5 Documented information). Environmental compliance has been systematically evaluated in the engineering department but not in the production.	3/5
9.2 Internal audit	Internal *safety* audits have been performed on different levels on regular basis. All auditors are highly competent. The safety audits have included some environmental viewpoints based on Metso Minimum Safety Standards and local regulations. Comprehensive environment-themed audits have not been performed separately. MEEP audits have not been performed.	4/5
9.3 Management review	No separate environment-themed management reviews have been organized for any management system or any other purpose, but environmental issues and data have been monitored together with	3/5

	safety issues. Acceptable risk level and adequate legislation follow-up methods have not been reviewed regarding environmental management.	
Clause 10: Improvement		
10.1 General	Examples of improvement include corrective actions, continual improvement, breakthrough change, innovation, and re-organization. The development pace has been considered good, especially in comparison with the resources available. Based on a quick comparison between different audit documents, audit findings have been taken care of. All employees have been able to write their HSE findings and ideas directly to the HSE personnel and to the local managers. All messages have been read, and all HSE-related incidents have been investigated. Personnel changes have been made when needed. No annual routine of evaluating HSE legislation compliance has been established. Following HSE-related legislation has not been seen as a chance to	4/5

	innovate or find new ideas.	
10.2 Nonconformity and corrective action	Nonconformities have been systematically reported in Sustanalyzer or InstaAudit or in site audit reports. Corrective actions have only been reported for audit findings. Corrective actions and responsibilities for them have not been reported systematically for nonconformities noticed by local employees. It is not possible to track the changes or the development stages unambiguously.	3/5
10.3 Continual improvement	The actions that support continual improvement have been determined. Elements of environmental management have been improved one by one. The importance of continual improvement is present in all communication.	5/5
	Sum of points given**	74 / 110

*) Description of the points given:

- ✓ 5/5 = excellent
- ✓ 4/5 = good
- ✓ 3/5 = only average, but satisfactory already
- ✓ 2/5 = not satisfactory
- ✓ 1/5 = no attention given to this yet, not satisfactory

**) The sum of the points given in this analysis is an unofficial way of tracking the development of the organization. The sum is not an ISO-approved measurement for evaluating environmental performance. It cannot be used as a certificate of conformity regarding legal obedience.